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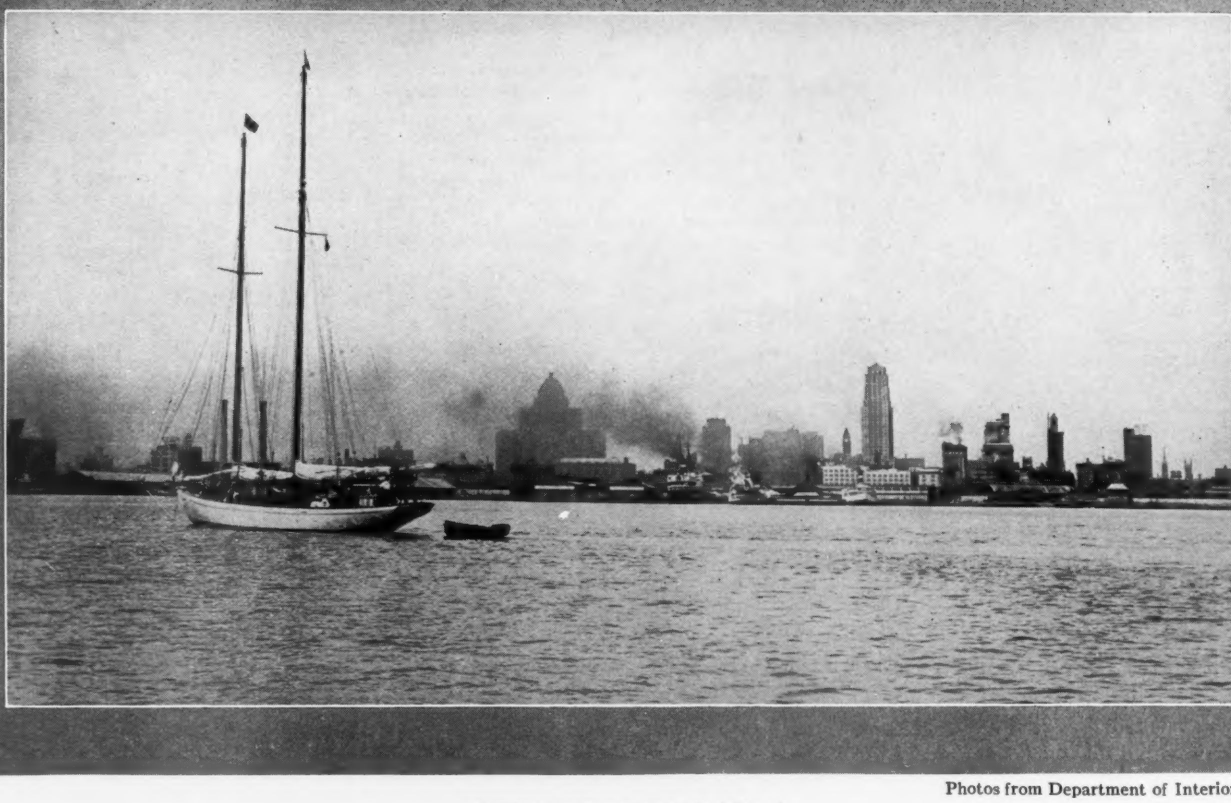
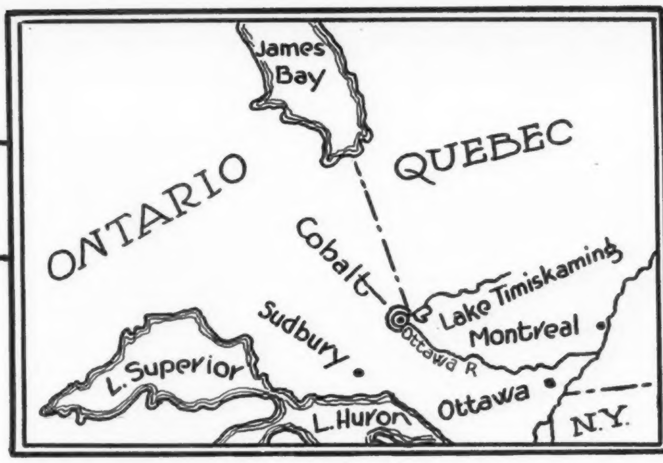


Photos from Department of Interior, Canada.

QUEEN CITIES OF CANADA

The fresh modernity of Montreal and Toronto, as revealed in these two pictures, typifies the speed with which the great Dominion has come ahead in recent years. Still a young country, Canada has enormous natural resources upon which to draw. None among them is more important than her mineral storehouses, and none has contributed more to the solid upbuilding of these two premier centers of trade and industry. In the past 30 years they have poured forth nearly $6,000,000,000. At the top is Montreal, viewed from Mount Royal. Below, Toronto's imposing skyline rises from her magnificent harbor.

PART 1. COBALT



GENERAL LOCATION MAP
Although relatively close now to numerous populous areas, Cobalt was a remote, little-known section at the turn of the century.

Thirty Years of Canadian Mining

R. C. ROWE

I
Which Serves as an Introduction

THIS is an outline of the history of a little more than 30 years in the development of Canadian mining. Thirty years is a mere flash in the mighty horizons of time encompassing the history of nations; but such a short period can often be fraught with tremendous importance and be heavy with consequences to a country. This is the case with Canada.

Canada during her entire existence had produced about $6,250,000,000 worth of minerals up to the end of 1934. Of that total, nearly $5,500,000,000 have been mined since the discovery, in 1903, of the silver-producing district known as Cobalt. This means that created capital to the extent of $5,500,000,000 has been poured into the economic structure of a people numerically small in a span of a little more than 30 years; and, as we contemplate this fact, it is reasonable to expect that the infusion of this created capital into the lifeblood of the country must have been accompanied by a general economic expansion.

The cold figures of government blue books tell the vivid story of the results of those years of history and development. In 1903, when Cobalt was discovered, the mineral output of Canada was $61,740,513. In ten years it reached an annual value of $145,634,812, and in 1929 it totaled $310,850,246. In 1903 the per capita production of minerals was $10.83, and in 1929 it was $31.28. In comparing these figures it must be borne in mind that the population of the country had almost doubled.

These are the high lights in 30 years of mineral expansion; and turning to the general economic development we find a corresponding expansion. In 1903, the annual production of manufactured goods in Canada was $500,000,000. In ten years it had attained a value of well over $1,000,000,000, and in 1929 it amounted to $4,029,371,340. In 1903, the total external trade of Canada (visible imports and exports) was $450,324,570, and in 1929 it was $2,654,575,166. In 1901, the population of the country was 5,371,315, and in 1931 it was 10,376,786.

Canadian Pacific Railway Photo

SILVER READY FOR SHIPMENT
The station at Cobalt, when the camp was in its prime, with four trucks of silver bars awaiting the arrival of a train. It is an interesting observation on the morals of those times that the valuable metal was handled and displayed openly.

A CANVAS COMMUNITY

Cobalt, like all other boom mining districts, sprang from the ground with a rush. This group of tents represents the beginning of the Coniagas Mine, which became one of the large producers.

From an almost obscure people Canada has grown in 30 years to be the world's fifth trading nation.

These are the facts told by statistics. They indicate an inseparable link between mining development and general economic expansion. They are a matter of very cold figures, but they form the background of the extraordinary cavalcade of dramatic and colorful events that began with the discovery of Cobalt. In this history we are only concerned with the spectacle of that cavalcade which started late in the year 1903, and which is yet carrying Canada onward.

The discovery of Cobalt signaled the beginning of Canada's real mining history, and it served as a center for wave after wave of pioneering and prospecting effort resulting in discovery after discovery. These in their turn resulted in the creation of community after community where before there had been only virgin bush. Each of these was conceived in hope, born in hardship, and reared through sheer tenacity before finally blossoming into prosperity.

As we glance back over the crowded years, we see how each discovery has contributed to the expansion and development of Canada; we see how each has contributed men and money and fresh impetus towards further effort; and we see how the North, in its steady unfolding, attracted to itself men of extraordinary character and strength from all parts of the world.

This history records that chain of events that has played so momentous a rôle in the economic destiny of Canada. In detail it must necessarily be incomplete, for even in 30 years the memories of men become dimmed and a lot of things become lost, but everything has been done to make it accurate. With its deficiencies, be they great or small, it is given as a tribute to men rather than to accomplishment, for, in the end, it is the human equation that resolves the formulae of national destinies. To those men, whose efforts have resulted in the establishment of a great industry, Canada owes a great debt of gratitude, and to them this history is respectfully dedicated.

II

Which Relates the Discovery of Cobalt

"We go to work in gangs of three,
Red-haired Mike and Bill and me;
There's no mistake, we're husky lads
That swing the sleds, and hold the gads.
Then drill, ye tarriers, drill."
—Old Song.

PREVIOUS to the year 1900, the great tract of land in the Province of Ontario lying north of that part of the Canadian Pacific Railway running west of North Bay to the Manitoba boundary was well-nigh unknown. True, there had been some mining and lumbering, but those operations had lain close to the railway, or along waterways. Practically the only exploration carried out had been effected by field parties of the Geological Survey of Canada which, by the way, had fairly effectively covered the whole of Canada. Thus, while there was some general knowledge of the possibilities of the country, that knowledge was vague and very indefinite.

It seems almost incredible that the region which has produced the great mining fields of Cobalt, Kirkland Lake, and Porcupine was classed as unexplored territory so recently as a little more than 30 years ago. Such, however, is the fact; and but for a strong manifestation of the pioneering spirit it might have remained in that category for a good many years longer. In the ordinary course of events—particularly modern events—the opening of such a territory might easily have been left to private enterprise or the vagaries of chance. But, actually, it resulted from a boldly conceived plan on the part of the government of the province; and its execution must always remain to the everlasting credit of the men who were directing the destinies of Ontario in those days.

Some time just prior to the open season of 1900, the Legislative Assembly of Ontario voted the sum of $40,000 to carry out a survey and exploration of the northern areas of the province. The object of this exploration was to attempt to assess the latent value of northern natural resources as a first measure towards developing the country. Ten parties were assembled, each consisting of a surveyor, a land and timber estimator, and a geologist. Each was assigned a definite area and given the open season of 1900 to complete its task. The proposal was a bold one, as exploration on such a scale had seldom before been tried. The area traversed by the parties was the whole of the Province of Ontario lying north of the Canadian Pacific Railway—a task of some magnitude, as everyone must admit. The reports of the various groups are incorporated in a closely printed volume, of nearly 300 pages, which was published in 1901 and which probably has been entirely forgotten.

Naturally, the area within what was then the District of Nipissing received close attention. The region, while largely unknown had been penetrated in the decades gone by the old French *voyageurs* who traveled up the Ottawa River to Lake Timiskaming. An old map dated 1744 shows a bay on the east side of the lake—now lying in the Province of Quebec—called Ance à la Mine. At this spot some work had been done on an outcrop of argentiferous galena in the early days. There had been some lumbering operations on the Ontario side of the lake, and two small settlements at Haileybury and New Liskeard had sprung up. Otherwise the area was unknown.

Two parties were assigned to this region in which are now located the great gold fields of Ontario. They duly noted the great clay belt, the timber resources, and the mineral possibilities of the district; and the closing words of the report of George R. Gray, who was in charge of Party No. 3, are tremendously interesting:

"On reviewing the information acquired by myself and party regarding the soil,

timber and minerals of this district, I beg to state that the immense natural resources of the newly explored tract of country are bound to contribute largely to the growth and prosperity of the Province. When the territory has been opened up by a railroad, a nucleus will be formed around which the lumbering, mining and agricultural industries will develop with rapidity, thereby inducing the settlement of these regions which now support only a few scattered families of Indians."

Prophetic words, these, of greater import than even the man who wrote them probably ever dreamed. But, be that as it may, the fact remains that he was a man of extraordinary vision; and the province he served so well could quite properly erect a tablet at North Bay, the gateway of the North, as a tribute to his vision, for the result of that inspiring venture into large-scale exploration was the beginning of the Timiskaming & Northern Ontario Railway which was started northward from North Bay with the north end of Lake Timiskaming as its objective. Its purpose was to develop the District of Nipissing.

The final sanction of Parliament for the building of the railway was not obtained without a struggle. The government of that day was dying; the opposition was strong; and the fate of an undertaking that was to play so picturesque a part in the opening up of the North hung in the balance during a strenuous sitting of the House. It was tossed about on a stormy sea of words, and the leader of the opposition contemptuously referred to the country it was to tap as "a waste of jackpine and stunted poplar." But it was finally passed. That was in 1902.

Then, in 1903, came the discovery of silver in the area which was to become generally known as Cobalt. It was entirely accidental, and like most accidental discoveries it has been clothed in picturesque legend until the exact truth of the matter has become obscured and lost. We have one certainty to start with in describing this momentous event in the economic life of Canada, and that is the fact that the business of cutting the right of way and of grading the Timiskaming & Northern Ontario Railway had, in August of 1903, reached the shores of an unmapped lake which had been christened by the construction gangs with the singularly unoriginal name—shared by many other lakes in Canada—of Long Lake. That at least is definite; but just exactly what happened from then on until the news of the silver discoveries filtered down to the outside world is somewhat doubtful. There are two stories existing, and about the best we can do is to take our choice of them.

One account, told with various embellishments, relates how two woodsmen, James H. McKinley and Ernest Darragh, were engaged in cutting ties for the roadbed of the railway at one end of the lake which afterwards became Cobalt Lake. During the process of snaking out their timber it was noticed that pieces of white metal were embedded in one of the sticks of softwood. The metal was silver. McKinley and Darragh were mildly interested, not so much because they appreciated the significance of the matter but rather because of curiosity regarding the origin of the metal. Obviously it had not grown there, and therefore it must have been picked up by the stick while being dragged through the woods. Investigation was natural under such circumstances, and they finally found the vein. They noted the native silver exposed by weathering, and located the claims which subsequently became the McKinley-Darragh Mine of which H. C. McCloskey—now director of several Canadian mining companies, including Howey Gold Mines and Teck-Hughes Gold Mines—later became manager.

COBALT IN THE ROUGH

A picture taken as the town was emerging from the bush. The buildings housed saloons, a mining exchange, a bank, hotels, assay offices, law offices, and restaurants, with the two last named in the majority.

The other story is more picturesque, and involves a blacksmith named Fred La Rose. He was employed by the railway builders, and popular legend has it that, while working at his portable forge one day, he threw a short steel at a fox that was impudent enough to pass close by. Naturally, he missed the fox; but, being a frugal French-Canadian, he decided to retrieve the steel. When he picked it up he found that it had gouged a piece of mineral from a vein in the surrounding rock. And so, presto, in the wink of an eye, as it were, one of the greatest silver districts the world has ever known was discovered. It is a pretty yarn, but a doubtful one so far as veracity of detail is concerned.

Irrespective of detail, it probably never will be definitely known who made the initial find; but it is a matter of record that proof of discovery was filed by La Rose on September 29, 1903, and by McKinley and Darragh on October 6, just one week later. It is most likely that La Rose, who knew something of rocks and minerals, having worked around the phosphate pits in the Buckingham District, noticed one of the silver-bearing veins, which were really conspicuous where exposed. There can be no reasonable doubt that other men must have seen them; but knowing nothing of mining, their significance passed unheeded.

The interest of La Rose, however, was definitely aroused. We can easily imagine that those heavily mineralized, clear-cut veins intrigued him and set him picking, with the result that it was a sample from his discovery which came into the hands of Thomas Gibson, who was then and still is Deputy Minister of Mines for the Province of Ontario. Curiously enough, La Rose did not seem to be particularly concerned about the silver in his vein. The mineral that took his errant fancy was niccolite, which he apparently mistook for copper ore. It was a sample of this that found its way to Mr. Gibson, who immediately sent it to Dr. Willet G. Miller, the provincial geologist whose name has become so intimately associated with Cobalt and whose work was to do so much to further the mining progress of Ontario.

Doctor Miller promptly recognized the mineral niccolite and, realizing the likely importance of the find, proceeded at once to the scene of the discovery. That was in November 1903. While he was fully alive to certain possibilities, the provincial geologist was not prepared for what he actually saw. This is not hard to appreciate, for the sight of the masses of native silver in those weathered veins must have been very impressive. The first vein visited by Doctor Miller was the one discovered by La Rose, who had by this time done a good bit of work and had sunk a small pit. Native

COBALT ON THE WAY DOWN

This is a later-day Cobalt. Much of its bloom has gone, but business still makes a courageous effort to carry on under the handicap of a diminishing population. The street is Prospect Avenue. At the left edge an old shaft house is visible.

silver was visible, and Doctor Miller took his pick and pried out a chunk of the metal about the size of his hand and nearly an inch thick. He showed this in Haileybury that night, with the result that there was quite a flurry of excitement and quite an exodus the next morning to the scene of the find. A number of claims were staked, among them being the property which later became "The O'Brien."

The following day Doctor Miller revisited the district and viewed three other veins. One of these was the McKinley-Darragh; another was a vein of massive cobalt on the claims which eventually became the Nipissing; and the third was one of the most vividly spectacular veins ever located in a region characterized by remarkable deposits. The latter was afterwards called the "Little Silver," and also became part of the Nipissing holdings. It was discovered by a Frenchman named Hebert who showed it to Doctor Miller with a good deal of reluctance. It consisted of an almost vertical fissure in a cliff 60 feet high. Its surface had been weathered by innumerable cycles of seasons until the native silver was exposed in great masses. In fact, the vein filling had so far decomposed that quantities of the silver had fallen down the cliff. Doctor Miller later described it as "a real textbook vein." It was, in fact, one of those occurrences that we sometimes read about and often dream about, but which human eyes are rarely ever privileged to see.

We shall never know the exact thoughts of the great geologist as he stood at the base of the cliff looking at that wonder-vein. All the imagination that is so much a part of the successful geologist must have been fired by the spectacle before him. That demonstration of nature's mighty chemistry must have profoundly stirred the scientist, and perhaps left him a little awed. He probably felt that those veins with their load of precious metal, which so moved his mind because of their scientific significance, would excite the cupidity of mankind to fever pitch, bringing into its train a great deal of evil. Knowing men, he appreciated that; and we have evidence that he was a little disturbed by the possible consequences.

But one wonders whether there, on that November day in 1903, he realized where it would lead: whether any premonition struck him of the march northward, and of the new era at the threshold of which he was then standing. Probably not, because that would have been beyond the power of mortal man; but the fact remains, and let it never be forgotten, that the real mining history of Canada dates from that day.

III

Which Concerns Cobalt's Development

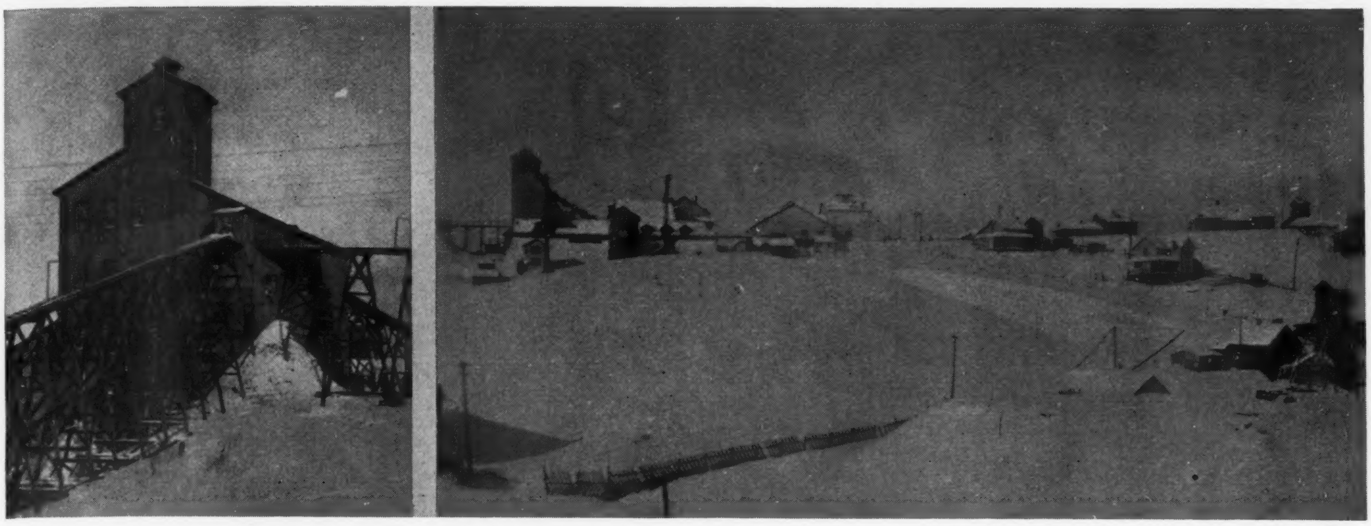
"Like all miners I've visions, which may some day come true,
Of where I would go and what I would do—
If I'd but once find the vein which carries the ore,
My days of hard work would forever be o'er."
—Thorp.

DOCTOR Miller's report on the silver discoveries appeared during 1904; but previous to that all information then available was given out through the medium of newspapers. Nothing much could be done during 1903, as the season was well advanced; but Doctor Miller was on the ground early in 1904, and there was a mild trickle of prospectors into the region. There was no great excitement, however. The prospectors on the spot went on searching for silver veins; and Doctor Miller, with his assistant, C. W. Knight, went on with the job of interpreting the story of the rocks. The results of their studies have been incorporated in several government reports and been the subject of innumerable technical papers, and those who seek detailed knowledge will find it there.

We shall content ourselves with the merest outline of the story which these two men traced in the rocks around Cobalt. They learned that the ancient Keewatin series of rocks had been overlain with a later system of conglomerates, quartzites, etc., which was christened the Cobalt series. Later again those two series were intruded by great diabase sills which had a gentle dip carrying them through both the Keewatin and the Cobalt. As the diabase cooled and contracted, innumerable cracks and fissures developed in the intruded rocks. These fissures were very narrow, seldom exceeding 8 inches in width and ordinarily being very much less than that. They were usually widest at the point of disturbance and narrowed as they receded from it. These cracks permitted the passage of ore solutions emanating from the diabase sills—which are generally accepted as the source of mineralization in the case of Cobalt—and a number of minerals were deposited. The most important of these were smaltite (diarsenide of cobalt), niccolite (arsenide of nickel), with some bismuth and calcite, etc. Later still, there was another slight movement that disturbed the many cracks—which had now become veins—and permitted the entry of silver-bearing solutions with a resulting deposition of silver.

This geological sequence was not generally understood at first, and there was a disposition to think that any vein carrying smaltite or niccolite would carry silver, while actually there was no positive reason why it should, as there was a long time-lag between the deposition of the older vein minerals and the later silver. On the other hand, however, there was no particular reason why it should not—it all depended upon a slight rock movement which happened when the earth was very young. It was most probable that the existing veins, which constituted planes of weakness, were affected by any subsequent rock movement. There also was the probability that if they were affected sufficiently to permit entry of the later solutions they would bear silver, but that if the veins were not affected, regardless of how much of the earlier minerals they carried, there would be no silver.

It was all a matter of chance, and as the movements governing it had occurred several millions of years ago, the men scurrying about the rock surface of the Cobalt District had no means of knowing whether those ancient structural movements had affected their own particular discovery (unless definite evidence in the form of native



LANDMARKS OF A FADED GLORY

Winter snows lie unbroken on the ridge above Cobalt which teemed with activity only a few years ago. On the right is a general view in which the Coniagas and Trethewey mines appear. The other picture shows the Trethewey mill.

silver was present, and in many cases it was not). And so they all presumed with natural unanimity that their veins had been affected, until it was proved that they had not been. This may sound involved, but it is actually a statement of fact that explains to some extent why, out of the hundreds of companies that were subsequently formed to work in the region, only comparatively few eventually became producers.

But returning to the story of the rocks of Cobalt, the third phase of mineral deposition was the formation of erythrite (hydrous cobalt arsenate) through the weathering of the cobalt minerals. This secondary mineral was generally known as Cobalt bloom. It was usually of a delicate pink shade, and was quickly discernible in prospecting. In the early days of Cobalt one heard much of it, and the sight of its characteristic coloring set many a heart beating faster and caused many a claim to be sold before even a pick had been stuck into it.

It was at this time that Cobalt received the name which has become so famous, and it was befitting that the man who thought of it should be Doctor Miller. The geologist had a mortal dread that the name Long Lake, temporarily given the little sheet of water near the discoveries by the construction gangs, would be perpetuated, and it probably would have been except for the fact that he had a happy thought. One morning he put in a post with a cross board at a point near the lake and inscribed on it, "Cobalt Station, T. & N.O. Rly." He also wrote and proposed the name to Mr. Gibson, Deputy Minister of Mines, who brought it before the railway authorities with the result that it was officially adopted. It was peculiarly appropriate; and was, of course, suggested by the ores of the district. The word "Cobalt" is apparently from the German *Kobold*, which means goblin—the ore being so called because it was always troublesome to the old German miners by reason of the presence of arsenic. Doctor Miller felt, however, that he could chance the visitation of ill luck, and so gave the district a name that is unique in its picturesque flavor and that has become known the world over.

After the minor happenings that have been chronicled there came a break in the orderly progress of development—a hiatus in the chain of events which it is hard to account for. In spite of their spectacular nature, the Cobalt discoveries fizzled like a wet squib, and created just about as much enthusiasm. Comparatively few prospectors were attracted to the region; and though those that were there staked claims on remarkable showings there seemed to be no public interest. Mining men were inclined to view the occurrences as freaks and were doubtful regarding their ultimate value. The general run of people did not yet know what it was all about.

This condition of suspended animation continued through 1904. Meanwhile, the few prospectors in the district were busy, and a few shipments of high-grade ore were made. Chunks of native silver, some of them as large as your hand, began to circulate freely in the cities to the south. Weird and wonderful stories began to be told around the lobbies of hotels and suchlike meeting places of men—notably the King Edward Hotel in Toronto where, so someone later remarked, more silver was mined than Cobalt ever saw, which was saying a lot. Still more weird and fantastic stories began to find their way into the newspapers, many of which were more concerned with sensation than with truth; and then, in 1905, the rush to Cobalt was on. The eyes of Canada, after a lot of wavering, were definitely turned northward. Before we turn to a contemplation of the Cobalt rush, however, it is worth while to glance at the events of 1904, because certain matters of importance to Cobalt, and Canada at large, were transpiring.

One of these was the fact that the La Rose claims had attracted the attention of certain men who were destined to become famous in Canadian mining annals. The beginning of this really goes back to the initial date of La Rose's discovery, for at that time he took his find to Duncan McMartin who was his boss and who had helped him to stake it on a fifty-fifty basis. Early in 1904 the news of La Rose's find reached Mattawa and the ears of the Timmins brothers, Noah and Henry, who, to make a long story short, bought out La Rose's interest. A private company was formed—made up of Noah and Henry Timmins, Duncan and John McMartin, and R. A. Dunlop—which operated the property until 1906, when La Rose Consolidated Mines Company was organized. In the very early days this property was generally known as "The Timmins"; and the effect of the entry of these men into mining extended far past Cobalt into other fields and times.

Another event destined to have far-reaching effects was the acquirement of Hebert's discovery, together with other holdings, by a group headed by W. B. Russell, a railway contractor. This in itself was not so important, but the group in question disposed of its holdings to E. P. Earle, of New York, who formed the Nipissing Mining Company late in 1904. This property became the premier producer of the district. Several of the men connected with it have left their indelible mark upon Canadian mining, and money obtained from it has been a potent factor in the development of another field. Messrs. McKinley and Darragh had purchased a small mining out-

DRILLING SCENES AT COBALT

Two of these underground pictures were made in the Beaver Mine, the third in the Trethewey. The center view shows an old-style piston drill.

fit and were engaged in opening up their property, which later became the McKinley-Darragh-Savage Mines of Cobalt, Ltd., another famous producer.

These were all initial discoveries; but the small number of prospectors that had been attracted to the region were busy, and several important finds were made. One of these was that of W. G. Trethewey, who discovered two great mines—the Trethewey and the Coniagas. Associated with him in this work was Alex Longwell, who was in the area for R. W. Leonard. Longwell also found the Buffalo Mine. Later Mr. Trethewey sold his claims, and Mr. Leonard became president of Coniagas Mines Ltd., with Mr. Longwell as vice-president. Both the Trethewey and the Coniagas became great shippers, while the latter established a record for low-cost production in the closing days of the camp and became an active element in the development of other fields. During 1904 Mr. Trethewey installed the first steam-driven plant in Cobalt, and in October of that year he shipped the second car of ore originating in that camp. By the time he sold out in the fall of 1906 he had taken out ore to the value of $600,000. From one open cut about 50 feet long and 25 feet deep Trethewey extracted $208,000 worth of ore, which illustrates the extraordinary richness of the veins.

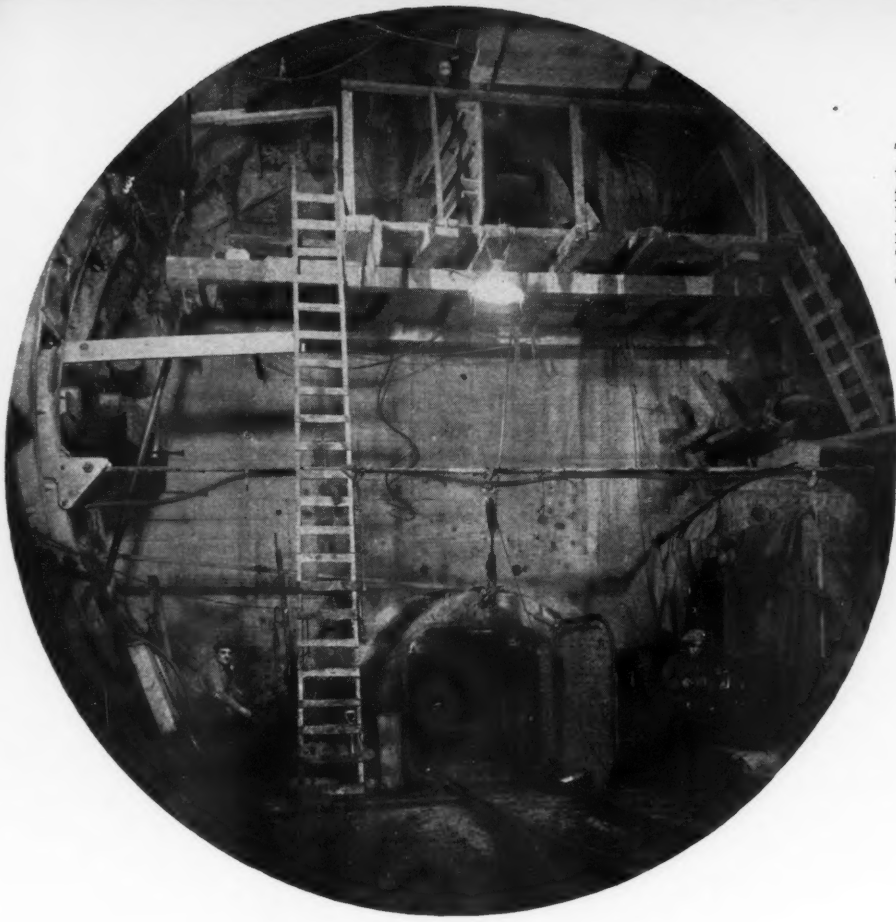
The autumn of 1904 saw several other major discoveries, among them being the University, Drummond, Kerr Lake, Nova Scotia, and Lawson—the latter being the famous "silver sidewalk." The Drummond and Kerr Lake were found by N. C. Wright, who sold the Kerr Lake Mine to J. A. Jacobs of Montreal (a figure in asbestos mining in the eastern townships of Quebec) for $36,000. The first consignment of ore from the property more than paid the purchase price: the sort of mine we all dream about but never find.

So, during the year, famous events were materializing, and the reverberations from them were reaching the outside world. The new camp was already producing, as 158 tons of ore were shipped valued at $136,218, or an average of $862 a ton. Then came 1905, and the deluge.

This is the first of a series of articles by Mr. Rowe. The second will appear in an early issue.

NIPISSING BULLION

These 381 bars of silver weighed 453,213 ounces and had a value, at the time they were produced, of $260,681. They were refined from ore from the Nipissing Mine. Each is stamped for delivery to Sharps & Wilkins, London.



AT THE BULKHEAD

This concrete plug holds the air pressure within the advanced section of the tunnel. Projecting from it are the boilerlike locks. The material lock is at the bottom center, the man lock to its right, and the emergency lock is overhead. This picture was taken from within the air chamber on the New Jersey end of the tube.

The Midtown Hudson Tunnel

Rapid Progress Recorded on New Subaqueous Vehicular Bore Being Driven by the Port of New York Authority to Handle Increasing Traffic

C. H. VIVIAN

TO FACILITATE and to accelerate the movement of the rapidly growing vehicular traffic between New York City and New Jersey, the Port of New York Authority is constructing a new tunnel underneath the Hudson River. It will cross from near West 39th Street in Manhattan to a point in the City of Weehawken, N. J. Work has been underway the better part of a year, and it is expected that the tunnel will be ready for service by 1938.

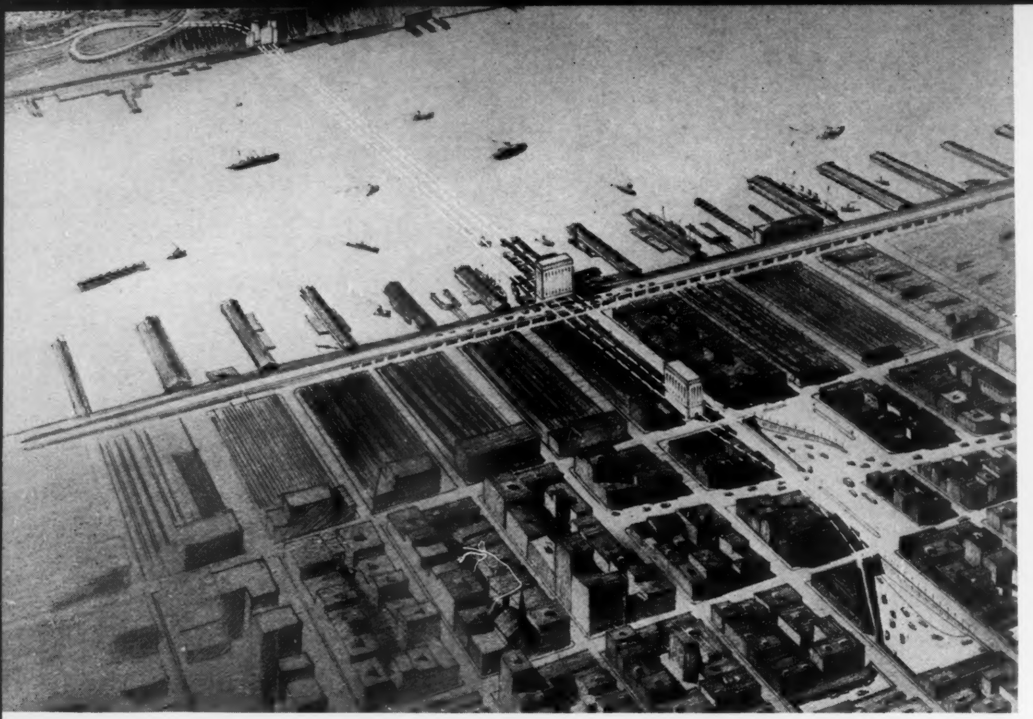
Until a little more than seven years ago, all vehicular traffic across the Hudson used the ferryboats which ply regular routes connecting numerous points on the two shores. These ferries had served the needs of horse-drawn vehicles for generations, but when the automobile came into general use it was soon seen that some other means of transportation would have to be provided. As a solution of the problem, the states of New York and New Jersey, through joint commissions, conceived the rather daring idea of tunneling under the river, and brought into existence the world-renowned Holland Tunnel, the first successful large bore of its kind.

When work began on the Holland Tunnel some twelve years ago, it seemed reasonable to assume that it would meet the needs of trans-Hudson vehicular traffic for some years to come. Even before that engineering marvel was put into service in November, 1927, however, it became apparent that additional facilities were essential, and, accordingly, the George Washington Bridge was put under construction. With its opening, in October, 1931, fixed crossings became available from both the northern and southern parts of Manhattan Island to corresponding areas on the opposite shore of the Hudson. But even these two structures have proved inadequate, and do not satisfy the demands imposed by the phenomenal increase in traffic. As far back as 1929 it was realized that it would not be long before a third stationary connection would be required.

A few figures will serve to emphasize this remarkable growth in travel across the Hudson. During the past seven years, traffic has mounted from 16,000,000 to 29,000,000 vehicles annually. In 1934 the Holland Tunnel carried 10,787,453 vehicles and the George Washington Bridge 6,152,-341. The total—16,939,794, it will be noticed, exceeded the entire vehicular traffic across the Hudson in 1928, which was the first full year that the tunnel was in operation. During the past four years, an average of 11,450,000 vehicles has used the Holland Tunnel annually. This means

WHERE TUNNEL WILL CROSS HUDSON

At the left is an aerial view up the Hudson, showing the location of the new tunnel with respect to the Holland Tunnel and the George Washington Bridge. Manhattan Island is at the right, New Jersey at the left. The picture at the right was photographed from Weehawken, looking across the stretch of the river the tunnel will traverse.



GENERAL SCHEME OF OPERATION

A sketch showing the plan of the projected twin tubes of which only the left-hand one is now being driven. It will carry 2-way traffic until the second bore is finished, after which it will be used by eastbound traffic only. The three ventilation buildings are prominently illustrated, as is the New-Jersey-shore loop that will serve as an approach and exit. In Manhattan a new street, eight blocks long, will be opened to assist in handling tunnel traffic. All told, more than 100 buildings will be demolished to make room for the approach system. Nearly $5,000,000 had been spent in the acquisition of this property up to January 1. The dotted line along the street bordering the river represents the new West Side Express Highway.

that 31,370 cars have passed through it every normal day, or an average of 1,307 an hour. During 1931, the peak year thus far, the volume rose to 12,756,174 vehicles, and in August of that year the traffic totaled 1,223,866 cars, which was at the rate of 28 a minute. The tunnel is now operating at more than 75 per cent of its annual capacity; and on Sundays and holidays, and during peak periods of every day, it is taxed to capacity.

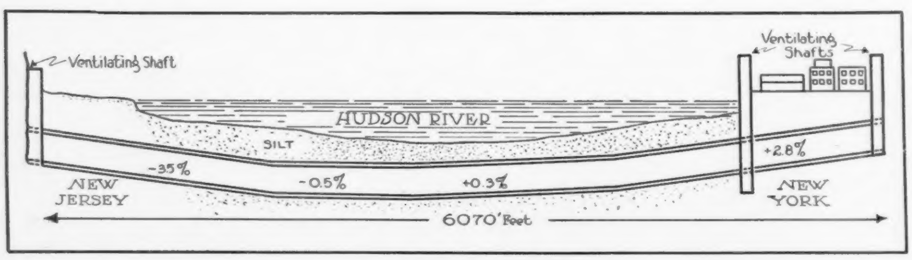
It is significant to note that the combined effect of the depression and of the opening of the George Washington Bridge has been to decrease the use of the tunnel by less than 16 per cent. The bridge, meanwhile, has shown a healthy growth in traffic despite continued unfavorable business and economic conditions. In 1932, which was its first full year of operation, it was used by 5,509,946 vehicles. There was an increase of 400,000 in 1933, and a further rise of nearly 240,000 in 1934, the figure for the year just past being 6,152,391.

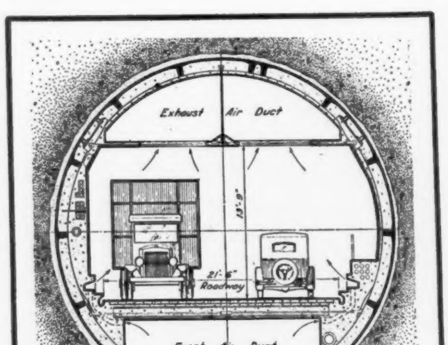
By subtracting the bridge and tunnel traffic from the total traffic, it will be seen that approximately 12,000,000 vehicles still cross the Hudson River annually on ferryboats. A considerable proportion of these would use a fixed crossing if one were within convenient reach. However, the distance between the bridge and the tunnel is about nine miles, and it is obvious that much of the traffic originating in the intermediate zones on the two sides of the river finds it quicker and more desirable to ferry across on more or less direct routes than to travel several miles along one or both shores in order to avail itself of the bridge or the tunnel.

From a traffic-density standpoint, the hearts of these intermediate regions are near the Times Square area in Manhattan and in the section immediately opposite in New Jersey. Surveys having established these facts, it was obvious that the third fixed crossing should be located so as to serve these two focal traffic areas. Fortunately, physical conditions were favorable to the establishment of the Manhattan terminal at a point almost exactly midway between 42nd Street and 34th Street, two thoroughfares that mark the northern and southern limits of one of the most heavily congested traffic zones in the city. Equally fortunate was the fact that the topography on the New Jersey side offered a suitable terminal, inasmuch as it permitted bringing the tunnel to the surface in an area where the Palisades, which guard the western shore, present a break just south of King's Bluff.

The tunnel now under construction is expected eventually to become a link in a more comprehensive plan. It is proposed to continue it across Manhattan and underneath the East River to Long Island, thereby giving through traffic an unhampered, underground express highway and at the same time relieving street congestion in one of the most crowded parts of Manhattan. This more ambitious program has had to be held in abeyance because of prevailing economic conditions. For like reasons it was elected to restrict current work on the Midtown Hudson Tunnel to the building of one of the two tubes which will ultimately be provided. Although it is eventually to be used only by traffic moving eastward from New Jersey to New York, the first tube will in the *interim* accommodate two lines of traffic moving in opposite directions. In the broad scheme which has been projected, it will become the southern unit of the twin tubes. Its companion will be built 60 feet to the north.

The tunnel will have an outside diameter of 31 feet, or 18 inches greater than the Holland tubes. Inside the concrete lining the diameter will be 28 feet, 4 inches. The roadway will be 21½ feet wide, sufficient for the safe operation of two lanes of opposed vehicles with room for turning out





SECTIONS THROUGH TUBE

The tube will be finished similarly to the Holland Tunnel, but the roadway will be 18 inches wider. The cross section (right) shows the scheme of ventilation and the position of the various service pipes and conduits. The elevated ledge at the right-hand edge is a walkway for the policing of the tunnel. Above is a longitudinal section. At its low point the top of the tunnel will be 70 feet below the surface of the river.

to pass in case of an emergency. The tunnel will be ventilated in the manner that has proved so highly successful in the case of the Holland Tunnel. Fresh air will be forced through longitudinal ducts beneath the roadway and will be liberated through openings along the curb lines. Vitiated air will be removed through ports in the ceiling; drawn out of the tunnel through overhead ducts; and discharged into the atmosphere by way of stacks rising from the ventilation buildings. Three structures will house the ventilating equipment, two on the New York side and the third on the New Jersey side.

Preliminary engineering studies for the tunnel were conducted by the Port of New York Authority with appropriations of $200,000 each made by the legislatures of New Jersey and New York in 1930. The report of these investigations concluded that the construction of a twin-tube tunnel was practical and economically feasible. It was submitted on January 1, 1931, and shortly afterward the Port Authority was authorized to proceed with the work. Ordinarily the project would have been financed by issuing bonds, but the acute stringency in the money market prevented such a course, and a delay ensued until funds could be secured. Negotiations were entered into with the Federal Government, and on September 1, 1933, a loan agreement was reached with the Federal Emergency Administration of Public Works for the advance of $37,500,000, it having been decided in the meanwhile to construct the tunnel in two stages.

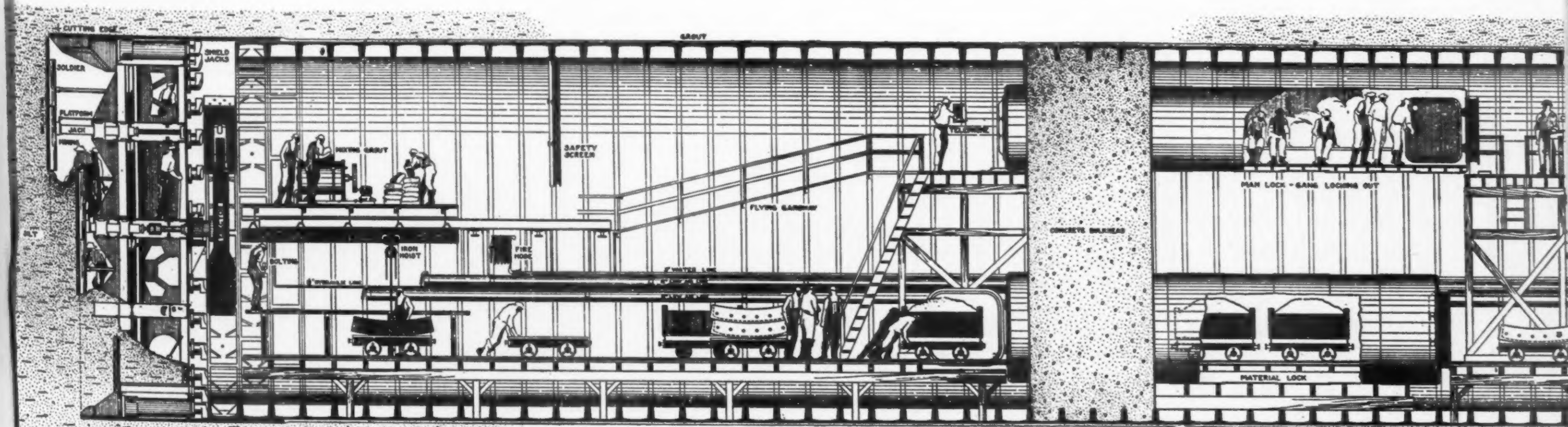
The tube now being built will have a length of 8,080 feet, of which 4,600 feet will be beneath the river. The principal contract at present underway covers 6,070 feet of tunneling, including the underwater section and the excavating of two of the three ventilating shafts. This work is being conducted by the well-known firm of Mason & Hanger Company, Inc., which has successfully carried out numerous large construction undertakings in New York and elsewhere. It obtained the contract on a bid of $6,452,300. Beginning at the inland ventilating shaft near Eleventh Avenue and West 39th Street in Manhattan, this section of the bore extends in a straight line to the New Jersey ventilating shaft at the foot of the Palisades. Nine hundred and eighteen feet from the starting point in New York it will reach the second ventilating shaft on that side. This is situated at the river bulkhead line, and is a concrete structure 42x52 feet in plan and 100 feet deep. It was built last year by the pneumatic-caisson method.

BOUND FOR NEW YORK

An unusual view showing the rear of the 400-ton shield entering the rock tunnel at the bottom of the ventilating shaft in New Jersey on its journey of nearly a mile underneath the river. The shoving jacks, by means of which the shield is moved ahead 30 inches at a time, are plainly seen. The partly completed lining rings were assembled to give the jacks something to work against and were later removed to permit enlarging the shaft.

Connecting links at the two ends of the section now in progress will be placed under contract at a later date. On the New York side the tunnel will continue in a straight line to its portal between Ninth and Tenth avenues where a new north-and-south street, eight blocks long, will be constructed as a part of the approach system. On the New Jersey side, the tunnel will extend from the ventilating shaft on through the Palisades for a distance of some 900 feet. This section will be excavated in rock, and will describe a curve that will carry it to the surface at the desired location. In order to attain the top of the Palisades from the point of emergence in the relatively low area selected, a loop highway, approximately 4,000 feet long, will be built. This will feed traffic to the north-and-south traffic arteries atop the Palisades and will then proceed westward as a depressed highway to the region of the New Jersey Meadows where connections will be made with other trunk roads.

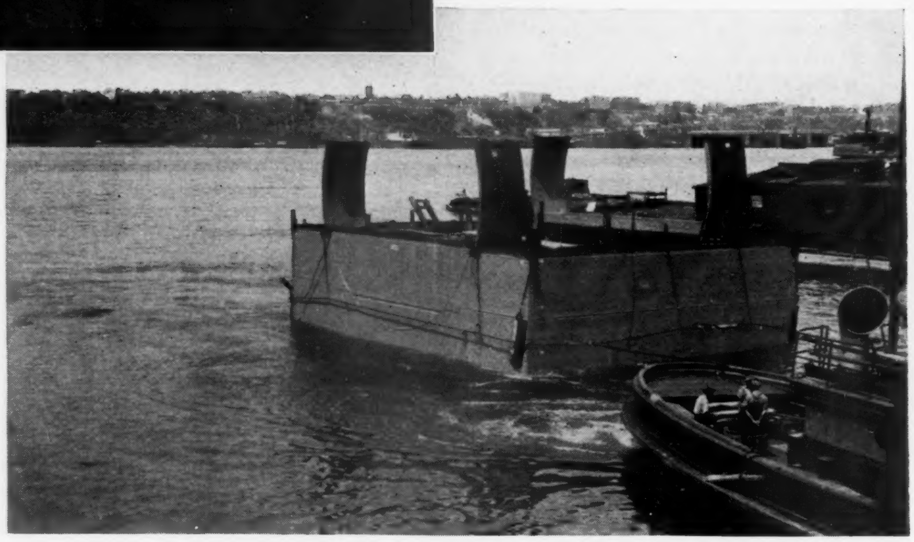
The work in charge of Mason & Hanger Company is being advanced from both sides of the river; but, owing to the different conditions that obtain, much faster progress is being made from the New Jersey shore than from the New York shore. As a result, it is expected that the shield which started from the western bank will have crossed the river by the time the one assembled in New York has reached the bulkhead line. Under this plan, the two shields will enter the caisson-built ventilating shaft from opposite sides and



LONGITUDINAL SECTION THROUGH TUNNEL HEADING SHOWING CONSTRUCTION OPERATIONS

VENTILATING-SHAFT CAISSON

The caisson for the ventilating shaft at the bulkhead line on the New York shore was fabricated at Kearny, N. J., by the Federal Shipbuilding Company and towed to its location. The picture below shows it being maneuvered into place by tugs. The partly completed rings mark the positions of bulkheads which will be removed later when the two shields arrive at the shaft from opposite directions. Sinking of this caisson started on July 23, 1934. Compressed air was applied on September 10, and on December 8 the structure was lodged on solid rock. At the left are drillers in the caisson working chamber putting blast holes in the rock ledge.



will be dismantled within that structure.

Operations began on the New York side with the excavating of the landward ventilating shaft. This is approximately 40 feet square and 80 feet deep, and is entirely in rock. From the bottom of this shaft the tunnel was opened and driven riverward in rock. It was carried full size for a distance of 360 feet in free air, and a smaller pilot bore was extended an additional 300 feet at the bottom of the tunnel line. At the 360-foot mark, the dip of the rock surface riverward had carried it close enough to the top line of the tunnel to allow water to seep in, and it became necessary to proceed from there onward with the aid of compressed air. Accordingly, a shield was assembled back of the ventilating shaft and moved into the breast, lining rings being erected progressively behind it to give the hydraulic jacks a firm bearing against which to shove it forward.

It is the profile of the rock line which makes construction slow and arduous on the New York side. Instead of sloping evenly, it exhibits an undulating surface the low points of which extend into the roof of the tunnel. In such sections the lower part of the breast is in rock and the upper part in soft, water-bearing material. Drilling and blasting must be carried on continually in front of the shield, and must be done with great care so as not to disturb the pressure equilibrium.

On the New Jersey side, as already stated, conditions are more favorable to rapid advancement. An opening of sufficient size and depth to permit assembling the shield was made on the site of the ventilating shaft at the foot of the Palisades and the shield advanced riverward by drilling and blasting rock ahead of it. After it was well on its way, a small construction shaft was sunk about 200 feet east of the ventilating shaft to provide more convenient access to the tunnel and to permit the subsequent enlarging of the ventilating shaft to proceed without interference.

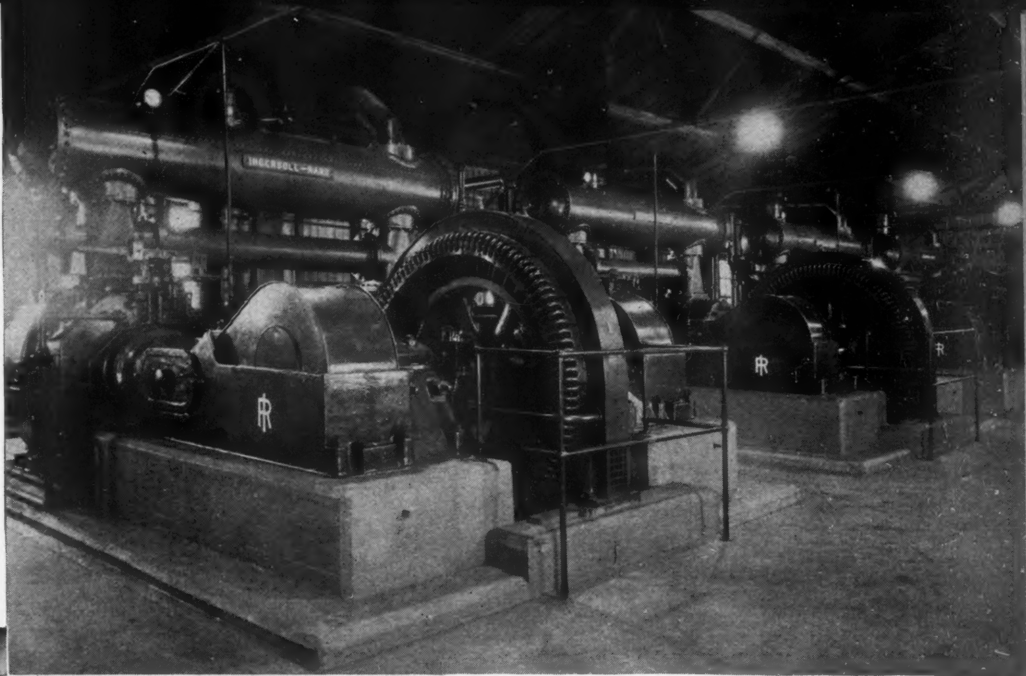
The rock line on this shore of the river drops off sharply and evenly, in contrast with the conditions on the opposite side. Accordingly, once the contact point between the rock and soft material had been passed there was nothing to complicate the operations; and the advancing of the shield has become merely a matter of conventional subaqueous tunneling, a phase of construction work with which the contractors are quite familiar because of former similar undertakings accomplished by them.

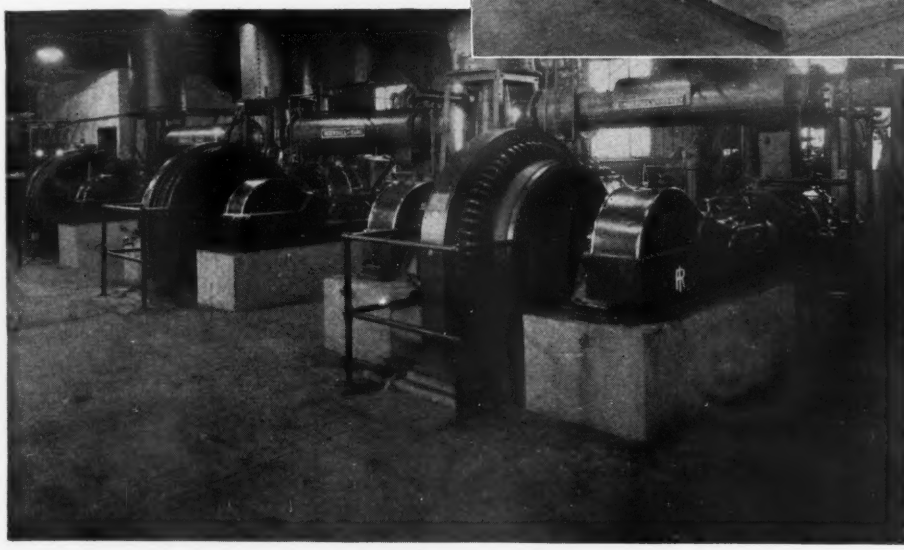
The top of the tunnel section is 62 feet below mean low water at the pierhead lines and 70 feet at its low point midstream. The cover is continuous, averaging 20 feet of typical Hudson River silt, and it was unnecessary to distribute a clay blanket prior to starting operations. As is customary when boring through such material, approximately two-thirds of the silt is pushed aside and one-third is admitted into the shield. It is not immediately taken out, however, but is distributed back along the floor of the tunnel lining to weight the structure down until the overlying material, which has been dislodged, assumes its former settled state.

The tunnel lining is of the conventional type, being assembled in rings 30 inches wide. Each ring is made up of fourteen segments and a key. The segments are 14 inches deep at the flanges and each weighs 3,000 pounds. Throughout the greater part of the tunnel the lining is of cast iron, but cast steel is used at points of transition from rock to silt and at points of unusual stress, such as at the entrances to the ventilating shafts. Fifty thousand tons of steel and iron were required for the lining segments, and 346,000 bolts will be used in joining them together, there being 145 to each complete ring. The bolts are of $1\frac{3}{4}$-inch section, are made of selected steel having a tensile strength of 85,000 to 90,000 pounds to the square inch, and are heat treated. Each bolt weighs 10 pounds with nuts and washers. The contract for manufacturing the lining segments was awarded to the Bethlehem Steel Company on a bid of $2,358,150. A portion of the order was later sublet to Davies & Thomas of Catasauqua, Pa. The bolts, nuts, and washers were furnished by the Oliver Iron

SOURCES OF AIR SUPPLY

There are seven motor-driven compressors on each side of the river. Four of these (right) furnish low-pressure air to the working chambers beyond the tunnel bulkheads to keep the river from inundating the tube. This is the third subaqueous tunnel job for some of these machines. Save for a short period during which a sump will be excavated at the low point of the bore, the air pressure used will not be higher than 26 pounds. The three other compressors (below) provide 120-pound air to operate rock drills and pneumatic equipment. These units are equipped with aftercoolers and, on their intakes, with Maxim silencers.





& Steel Corporation at a price of $178,000.

The contractor is advancing the shield at a fast rate, the progress being attributable to the well-organized crews and to the use of special equipment. The shield is a 400-ton structure, is equipped with 30 hydraulic jacks for shoving it ahead, and has twelve compartments through which work can be conducted. A hydraulic wrench for running up and tightening lining bolts was developed especially for this job and has been the means of speeding that essential operation. Although the shield was started on its journey five weeks behind schedule, it has already more than made up the lost time, and its present rate of progress indicates that it will reach its objective on the New York shore line by next October, or some two months before the date initially set. During one week of work in February, 57 rings of lining were erected, accounting for an advance of 142½ feet. This is believed to be a record for this type of construction in the New York area. The greatest progress made in any one week on the Holland tubes was the erection of 53 rings.

As the work is being done under Federal emergency regulations, working hours are limited to 30 a week. Four shifts of six hours each are employed, with a so-called floating crew to fill in so that operations may go on continuously. In the case of those working under air pressure, a shift is divided into two periods of three hours each, with a rest interval of three hours between periods. Relatively low air pressures are being used, and the maximum that will be required in the tunnel will be 24 to 26 pounds, although the construction of a sump at the low point for the collection of water will, for a short while, call for somewhat higher pressures.

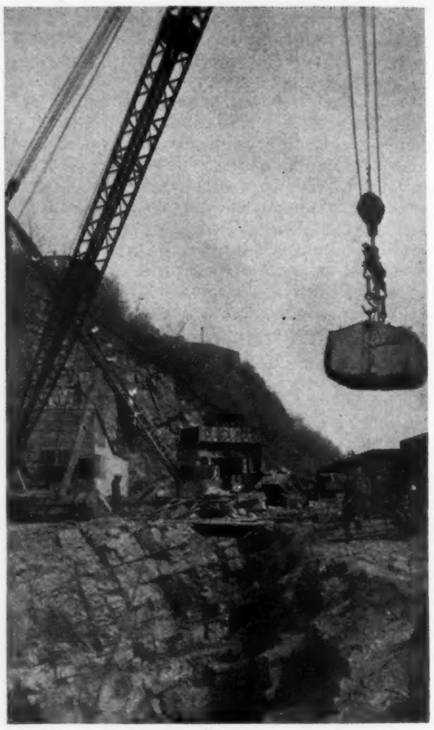
As is usual on subaqueous tunnel projects, a considerable plant and equipment are stationed above ground at either end of the line to provide vital services within the bore. An adequate and reliable source of low-pressure air for continual feeding into the chambers beyond the bulkheads is, naturally, one of the primary considerations. For the purpose of supplying this air there are duplicate compressor installations on either side of the river. Each consists of four Ingersoll-Rand Class PRE single-stage machines. Each unit is capable of delivering 5,600 cfm. of air at 30 pounds discharge pressure, and is driven by a direct-connected synchronous motor of 625 hp. As a precaution against stoppage of the compressors by reason of power failure, electric feeder lines from three separate sources of supply are available. This is the third important underwater tunnel job on which some of these compressors have served. In addition to the low-pressure compressors, three 2-stage machines on each side of the river furnish operating power for rock drills and pneumatic tools. These six machines also are direct-connected, synchronous-motor-driven Class PRE's. Each has a piston displacement of 1,302 cfm. and discharges at 120 pounds pressure. Blacksmith shops at either end of the tunnel include a Type 50 sharpener and a No. 27 oil furnace for reconditioning drill steels.

Another indispensable requirement underneath the river is hydraulic pressure for operating the shield jacks and, in this case, for supplying power to the wrench with which the lining segments are bolted together. This pressure is provided by Watson-Stillman equipment installed in the compressor house on either shore. On the New Jersey side, three 12-inch-stroke plunger pumps, each driven by a 100-hp. motor, build up water pressure for an accumulator which stabilizes the pressure and feeds the water to the lines leading into the tunnel. The pressure currently needed for shoving the shield ahead is about 4,000 pounds per square inch. A separate pump and accumulator furnish pressure at around 825 pounds per square inch for operating the bolting mechanism. The equipment on the New York side consists of two 12-inch pumps and an accumulator and also was supplied by the Watson-Stillman Company.

One interesting phase of the work, aside from that going on beneath the Hudson River, is the sinking of the ventilating shaft on the New Jersey shore that is now nearing completion. As previously stated,

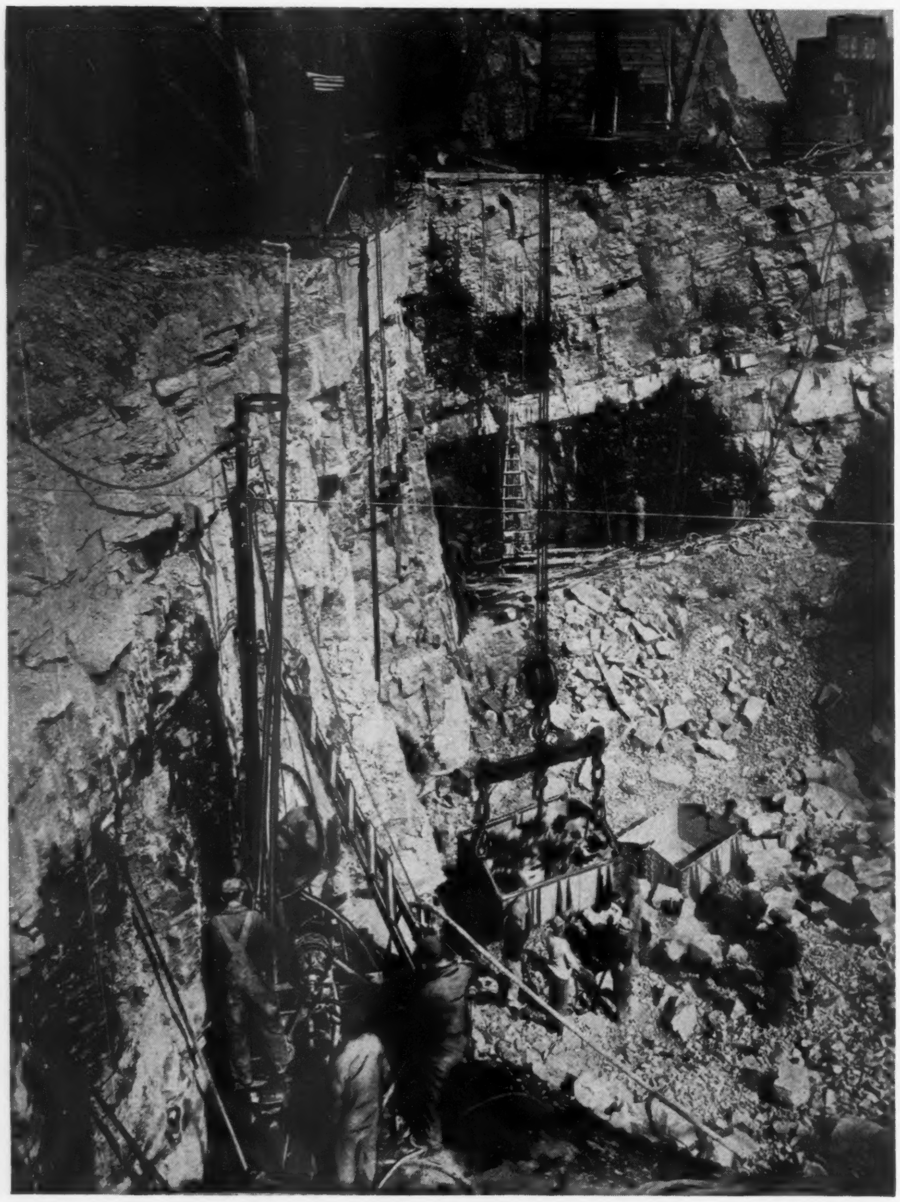
this shaft at the foot of the steep bluff of the Palisades, which rise to a height of more than 100 feet at this point, was partly excavated to provide a place for erecting the shield and starting it on its way. In order to clear the site to the general ground level, it was necessary to cut back into the projecting base of the cliff for a considerable distance and to scale the face for a height of some 60 feet, thereby providing a virtually perpendicular back wall which was to be continued downward and form one side of the shaft. This having been done, a 30x40-foot opening was carried to a depth of 55 feet; the shield was erected at its bottom; and the lower portions of the lining rings were assembled in order to assure a foothold for the shoving jacks. The tunnel riverward was then begun through the rock wall. Until the bore had been driven past the location of the smaller construction shaft, 200 feet distant, the rock excavated in front of the shield was taken back along the tunnel line and hoisted to the surface through the rearward shaft.

The enlargement of this ventilating shaft called for increasing its cross section throughout to 65x105 feet and excavating it to a depth of 55 feet. Something more than 10,000 cubic yards of rock had to be removed. After a start had been made with hand-held drills of the "Jackhamer" type, it was realized that greater progress could be made with heavier equipment, and two Ingersoll-Rand Type D wagon drills were moved in. The size of the opening was such that the benching method could be employed. Holes spaced on 5-foot centers were drilled 20 feet deep ordinarily and 30 feet occasionally. Working two shifts a day, the two drills normally put down holes sufficient to break about 400 cubic yards of rock. The rock consisted of bands of shale and sandstone, interspersed with the characteristic basalt of the Palisades lava intrusion. Ten-foot drill steels with bits forged on them served as starters, and the holes were then finished with "Jackbits." Broken rock was loaded into 5-cubic-yard bottom-dump "battleships," which were hoisted by derrick. Spoil was deposited in railroad cars on the tracks adjacent to the shaft and hauled to points along the river for disposal.



EXCAVATING NEW JERSEY VENTILATING SHAFT

The scene below, owing to the huge size of the opening, looks more like a quarrying than a shaft-sinking job. Wagon drills are working in the left foreground and at the far wall. In the bottom of the pit a 5-cubic-yard bucket of muck is leaving the ground on its way to the surface. The picture at the right shows a load about to be dumped into a railroad car for haulage to the disposal area along the riverfront.



Calculations based upon an independent survey conducted for the Port of New York Authority indicate that 1,800,000 vehicles may be expected to use the Midtown Hudson Tunnel in 1938, the first year it is scheduled for operation. It is further estimated that in 1943 the two tunnels and the bridge will carry 30,696,000 vehicles, or nearly double the number that used fixed crossings in 1934.

The design of the Midtown Hudson Tunnel was prepared by the engineering staff of the Port of New York Authority under the supervision of O. H. Ammann, chief engineer, and Ralph Smillie, engineer of design. Maj. Charles S. Gleim is construction engineer for the Port Authority. Resident engineers are Charles L. Crandall and Jacob Mechanic. The work of Mason & Hanger Company, Inc., is in charge of Miles I. Killmer, manager of the firm. Howard L. King is the resident engineer, and George B. Montgomery and William R. Ury are serving as superintendents, the former on the New Jersey side and the latter on the New York side.

Plating Glass with Metals by Aid of Vacuum

As is often the case, work in the laboratory will lead investigators into channels quite apart from their lines of research and thus, accidentally, to discoveries of importance. It was while studying the phenomena accompanying the discharge of electricity through highly rarefied gas that the metal cathode—the negative pole—was observed to disintegrate when the vacuum reached a certain point, that is, to scatter finely divided particles in all directions. The significant thing about this was that the particles adhered firmly to glass, giving it high reflecting powers.

The first practical result of this discovery was the production in the physical laboratory of nontarnishable mirrors. These consisted of platinum-coated glass and were made for scientific and optical purposes. In the meantime, the deposition of metal on glass in vacuum has reached a practicable stage. Two methods have been developed, the character of the metal determining the one to be used. One is the so-called sputtering process, and the other, of a later date, the evaporation or vapor-plating process. Both operate on the same principle, the main difference being that in the latter case the metal is melted in a crucible while in the other the cathode provides the metal with which the glass is coated.

The apparatus that have been devised for this work are shown by the accompanying line drawings and, essentially, consist of a bell jar, B. In the case of the sputtering process, the jar is sealed by a metal stopper through which is passed a lead from the negative high tension which carries the cathode, K. The top of the jar is protected from the attack of the metal particles by a glass disk and tube, D and T, respectively. The metal base plate, on which the jar rests, is the anode to which is attached the positive high-tension lead—1,000 to 10,000 volts. The glass to be plated, G, is supported beneath the cathode and, under circumstances, is heated to incandescence before treatment by means of a coil, C, so as to assure a uniform distribution of the metal. This is necessary when an opaque coat is desired, for otherwise the bombardment of the diminutive missiles, combined with the high vacuum, would effect the release of the gas that glass is known to adsorb throughout its surface and cause it to break through the metal film, thus riddling it with holes. When the work in hand calls for the use of heavy currents—50 milliamperes—it is advisable to cool the jar by a fan and the cathode with water. Both the glass and the cathode are thoroughly cleaned before they are placed in the evacuated chamber, the latter by sand-blasting.

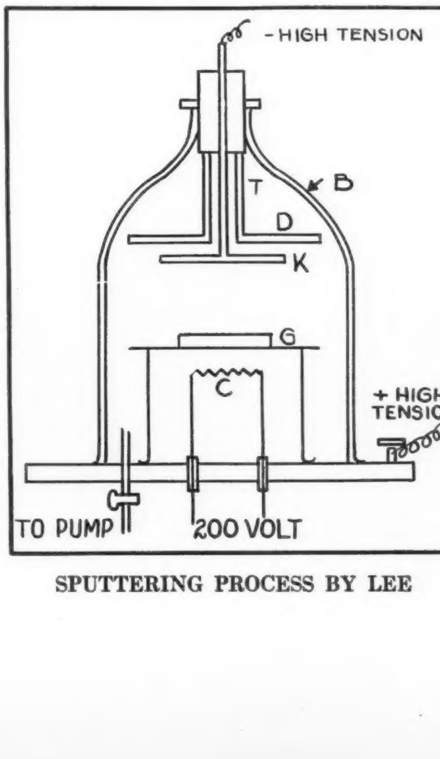
Deposition is found to be fairly constant, and is at the rate of a layer ranging from about one-millionth of a millimeter to one-hundred-thousandth of a millimeter in thickness per minute. An opaque coat, approximately ten-thousandths of a millimeter thick, can be applied in a few minutes. Heavy metals such as gold, platinum, silver, etc., sputter quickest–in from ten to fifteen minutes; copper, iron, and nickel, take twice as long; and tungsten still longer. Light metals, on the other hand, aluminum, magnesium, chromium, and silicon, are more easily evaporated.

In the case of the latter method, the glass plate, G, is held above a tungsten-wire heating coil, C. This coil is in the form of a helix and is converted into a crucible which, except with metals having a high melting point, is covered with alundum and baked. Otherwise the metal is placed in a container made of tungsten filament. To prevent impurities reaching the glass, it is good practice to cover the crucible with a shield which can be lifted by an external magnet after the metal has begun to evaporate. The coil is raised to a potential of 200 volts above the metal base plate, causing the metal vapor to become luminous and to assist deposition. This is effected in a few minutes.

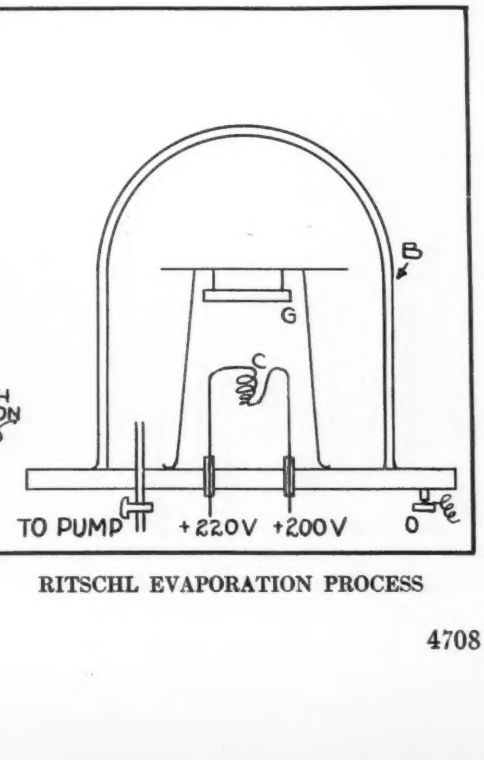
The apparatus just described is for small work only: for large mirrors more coils or crucibles are needed. For example, the 36-inch reflector of the Lick Observatory was made by the use of twelve coils. It is surfaced with aluminum, which was applied under the direction of Dr. J. Strong of the California Institute of Technology. The plating is one-thousandth of a millimeter thick and was done in three minutes.

Depending upon the ultimate service of the product, the processes can be timed to give transparent or opaque films which, by means of templates, can be shaped variously, as may be desired. The films obtained both by sputtering and by evaporation have been found to adhere well—in fact, better than chemically deposited ones. At the present time, sputtering costs more than the familiar "silvering" in the case of large-scale operations. However, this is offset by the many advantages which the process has to offer in the making of silvered and semi-silvered mirrors for scientific and optical purposes as well as gold- and platinum-coated mirrors which, though they lack the reflecting power of silver, are proof against atmospheric corrosion.

The newer process is said to have endless possibilities; and there is a wide field of application for glass plated with aluminum, chromium, silicon, etc., which are easily deposited by evaporation. The photographer, for example, who has ultra-violet rays to contend with, will find aluminum reflectors from five to ten times more efficient than silver ones because the latter, despite the fact that it has the highest reflecting power of any metal in the visible region, rapidly loses that power in the ultra-violet region of the spectrum. Besides, aluminum does not tarnish. Where the extreme ultra-violet wave length comes into play, silicon is highly reflective; and chromium is effective in the infra-red region. Alloys also are suitable for vapor-plating, as evidenced by the work of the German optical firm of Carl Zeiss and by Dr. H. W. Edwards, physicist at the University of California. Both use a magnesium-aluminum alloy. Doctor Edwards has named his material "pancro" because it reflects all colors alike.



SPUTTERING PROCESS BY LEE

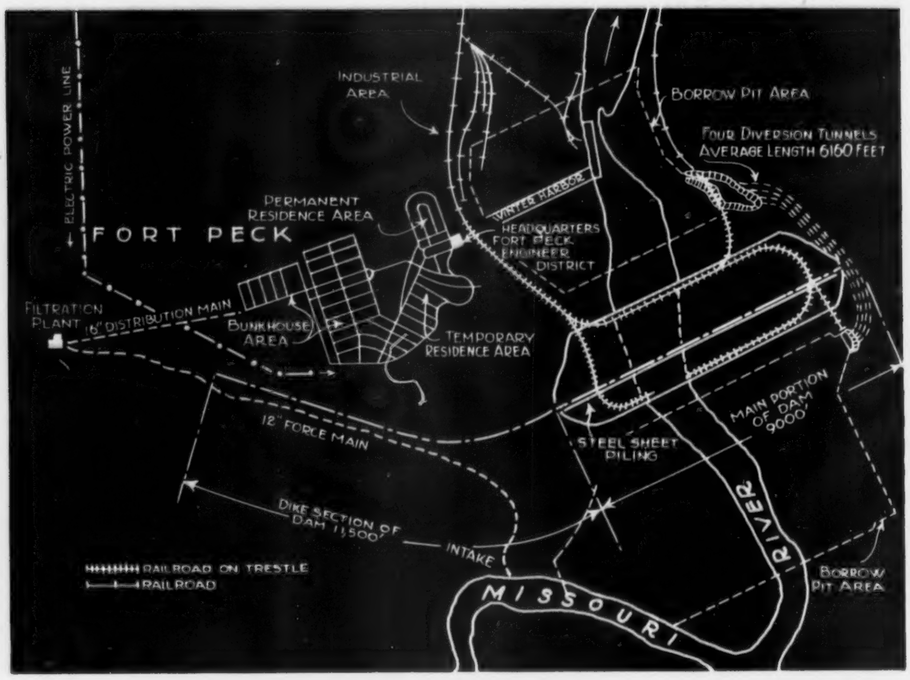


RITSCHL EVAPORATION PROCESS

Fort Peck Dam

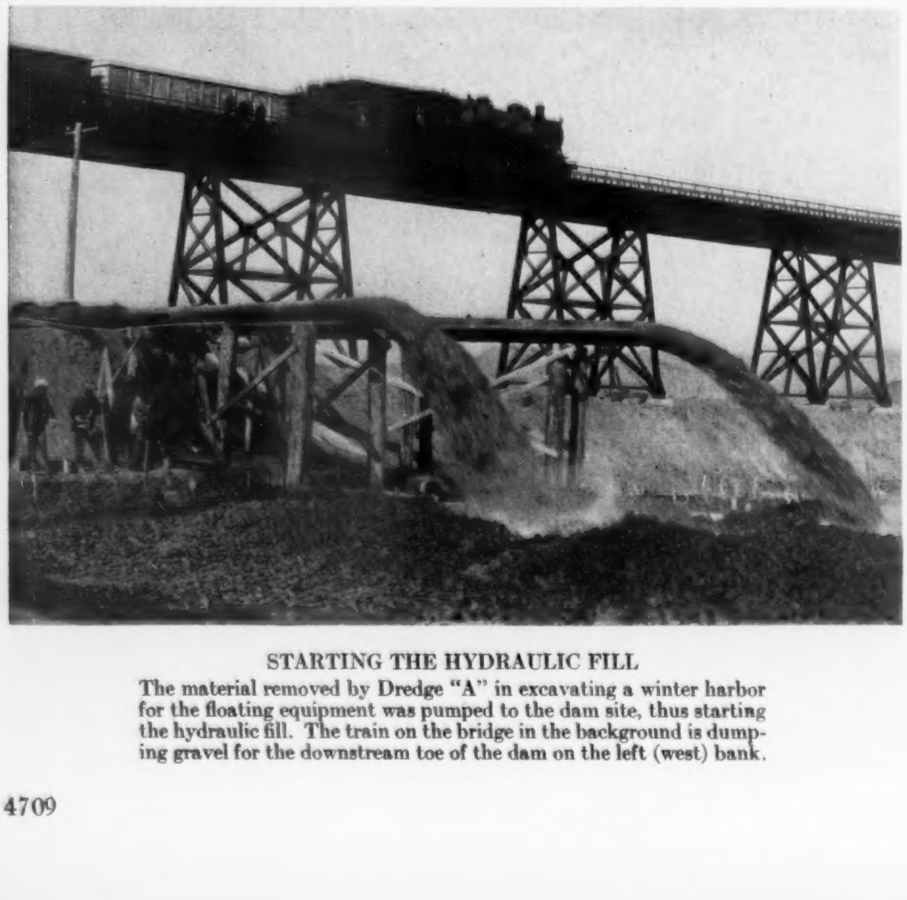
Part 2—General Construction Features

HAROLD O'CONNELL



MAP OF WORKING AREA
Showing the dam site, the Town of Fort Peck, and some of the principal construction features. Some idea of the gigantic proportions of the project may be gained from the realization that the area represented here covers approximately 28 square miles.

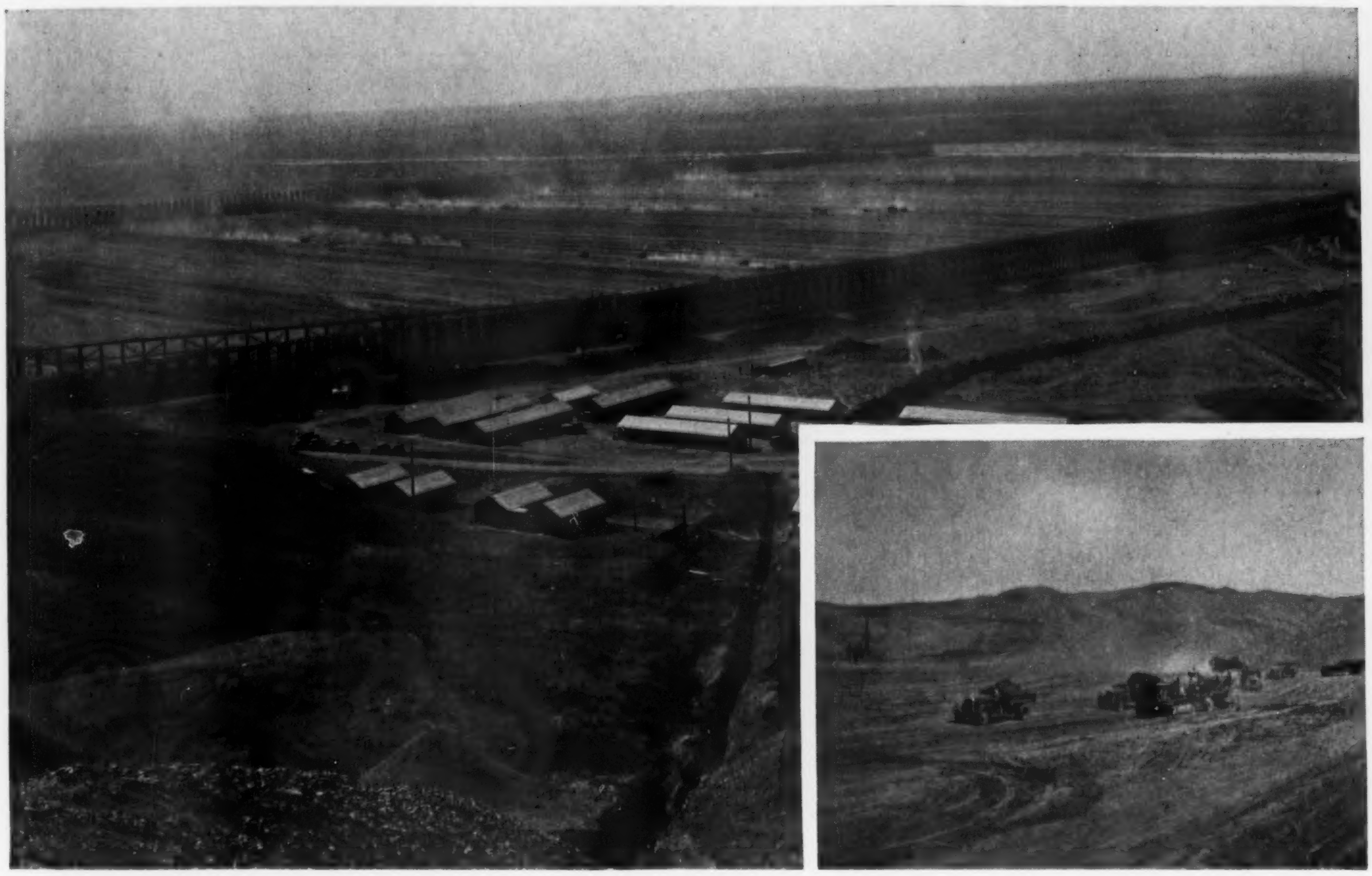
ONE OF the most spectacular of the preliminary operations at Fort Peck was the stripping of the overburden from the area forming the base of the dam. This blanket varied in thickness from 5 to 25 feet, and involved the excavating of 4,133,530 cubic yards of material such as "gumbo," a clay consisting of disintegrated shale and of loam, roots and vegetation. Fleets of 3- and 4-cubic-yard trucks moved in continuous lines from the several graders and draglines on the job to the spoil areas. The average haul was slightly more than two miles, while the working zone was approximately 2,700 feet by 7,400 feet in extent. Because of the large-scale use of elevating graders, each of which produced as much as 514 cubic yards of muck per hour, so much dust was raised that operators and truck drivers wore dust filters and goggles for nose, lung, and eye protection. The contract for this work, which amounted to $1,292,320, was completed in the fall of 1934 through the joint efforts of Addison-Miller, Inc., and Fielding & Shepley, Inc., both of St. Paul, Minn.



STARTING THE HYDRAULIC FILL
The material removed by Dredge "A" in excavating a winter harbor for the floating equipment was pumped to the dam site, thus starting the hydraulic fill. The train on the bridge in the background is dumping gravel for the downstream toe of the dam on the left (west) bank.

As will be noted in the accompanying cross-sectional drawings of the dam, the great bulk of the structure will be of alluvium fill, with a central core of comparatively impervious material. Its downstream toe will be formed of coarse gravel, which will be dumped directly from railroad cars running the length of the Missouri River bridge and trestle which are in line with that part of the dam. On the upstream or reservoir side there will be placed a 2-foot layer of gravel. This will serve as a cushion for a facing of derrick stone, blocks of quarried igneous rock that will have a minimum weight of 4 tons each. Some 4,000,000 tons will be required for this purpose, and each block will be set at an angle of 30° to the face of the dam. According to present tentative plans, there will be a concave-faced rubble-masonry seawall 22 feet high at the crest of the dam. Just behind this wall will be a concrete highway connecting the Town of Fort Peck with the east bank of the river.

To prevent water from seeping in under the base of the dam and through subterranean channels that may exist beneath the surface of the flood plain, a steel-sheet-pile cut-off wall is being driven through the alluvium to the firm shale floor of the valley. This shallow-arch interlocking piling is being forced to a maximum depth of 155 feet below the ground surface. Each of the succeeding sections is jetted with



MOVING DIRT FAST

The last of the stripping operations, during which more than 4,000,000 cubic yards of overburden was removed from the dam site. The inset shows a Caterpillar tractor and elevating grader which moved earth at the rate of nearly 10 cubic yards a minute.

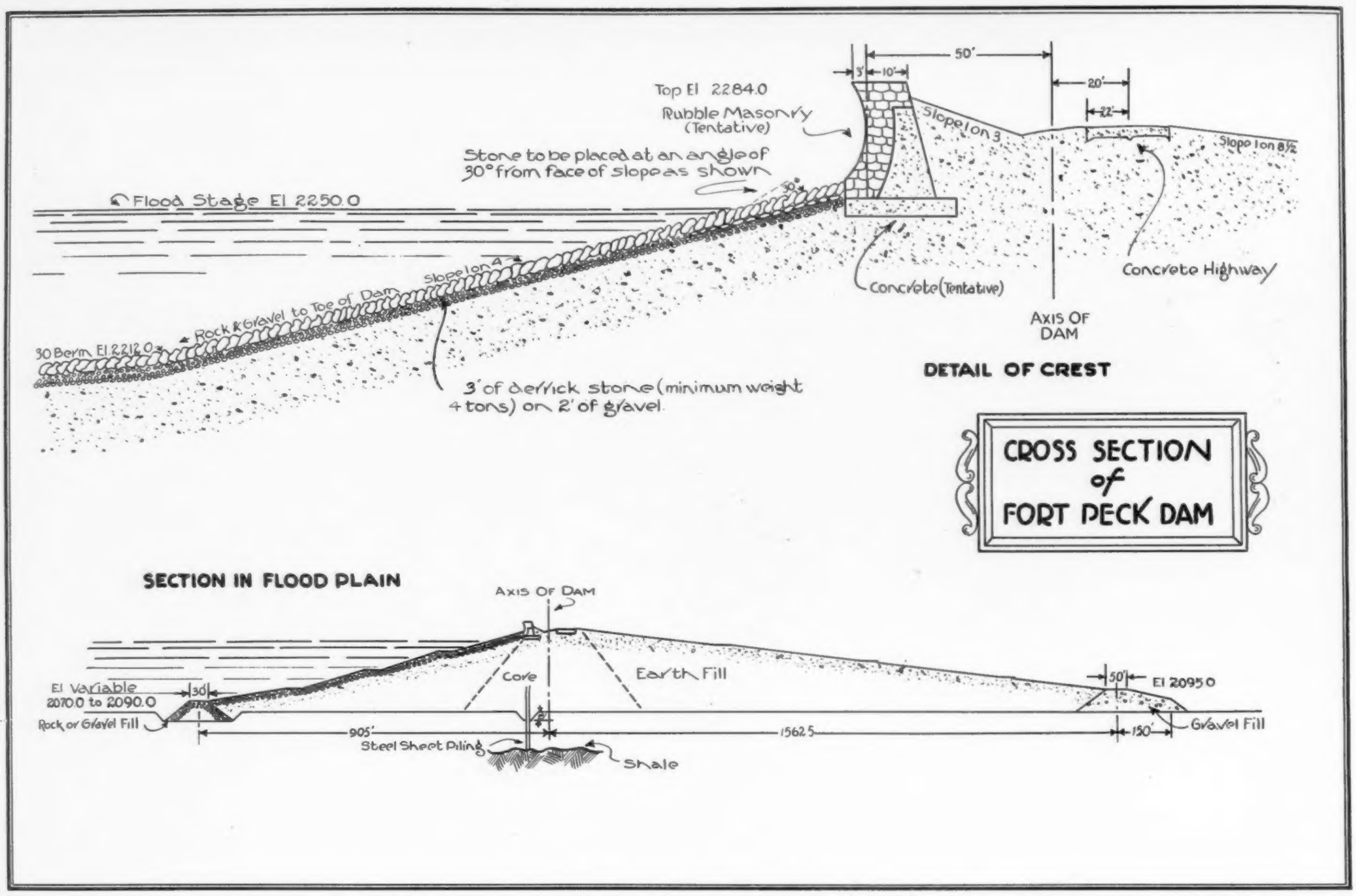
streams of high-pressure water and driven at the same time with double-acting hammers using compressed air instead of steam. The hammers operate from 196-foot gantry cranes which ride along the line of the cut-off wall on paralleling railroad tracks. With the sections for the first tier in position, additional lengths of piling are set on top of them and butt-welded.

To facilitate the sinking of the lowermost row of piling, a novel implement was devised for jetting the holes in the river bed. Frazier-Davis Construction Company and G. L. Tarlton, the contractors, both of St. Louis, Mo., have given it the name of hydraulic spade. It consists of a 70-foot length of sheet piling to which is welded the 4-inch jet pipe. The noteworthy feature of the tool is the bottom end, where the water emerges from the pipe. There a steel plate, about 2 feet long, is welded to the piling. Between the web of the piling and the plate are four channels for the flow of the jetting water—the pipe being flared out to receive those channels. By this arrangement, a wide stream of water is discharged that excavates an oval-shaped hole. The device has done much to speed up the work of setting the initial course of piling for the cut-off wall.

These operations had to be halted for a while during the severest part of the winter because of the extreme cold to which the workmen were exposed and because of

COLD-WEATHER CONSTRUCTION

The dumping of gravel at the downstream toe of the dam continued throughout the winter. Dredged material is being discharged at the right.



WHERE THE DAM WILL RISE

The cut-off wall under construction and the wooden spillway used to carry off the water draining from the hydraulic fill to the left of the wall. The area between the wall and the earth dike will be filled with selected materials to form the core of the dam.

difficulties experienced with freezing of the jetting water. But activities have now been resumed, and it is expected that the entire 9,520 feet of wall will be finished this summer. It is said that the steel sheet piling is being successfully driven to much greater depths than it has ever been sunk before. The top of the wall extends about 25 feet above the present ground level and into what will be the core of the dam.

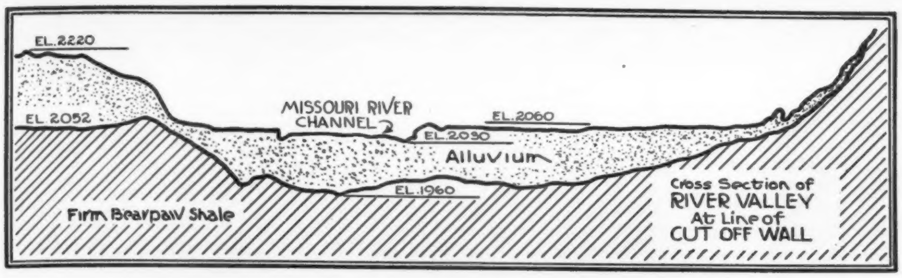
After the completion of the cut-off wall, a trench 15 feet deep and 10 feet wide will be excavated on either side of it to form a key for the core. The latter will consist of specially selected materials which will be placed so as to make the structure relatively impervious. The core will rise to the crest of the dam and will have a base approximately 600 feet wide.

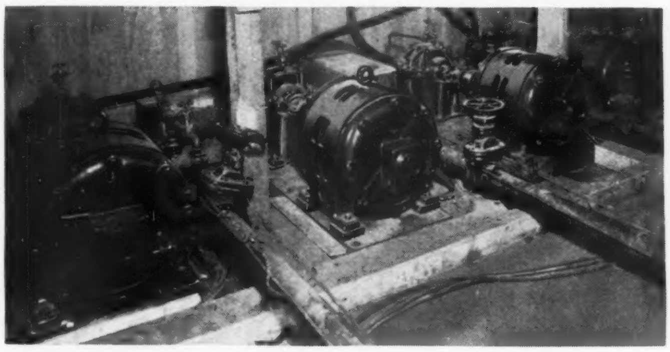
Although the greater part of the work on the appurtenant features of the dam will be in the hands of general contractors, it has been decided that the actual placement of the 100,000,000-odd cubic yards of fill will be done by Government forces with the aid of hired labor because of the need of rigid control and the unusual construction hazards. To accomplish this with a minimum of cost and a maximum of control, the hydraulic method was determined upon. Hydraulic dredging is not new to the men in charge at Fort Peck. Indeed, the majority of the army engineer officers stationed there have had experience with dredging problems on the lower Mississippi. Investigation by them revealed that the

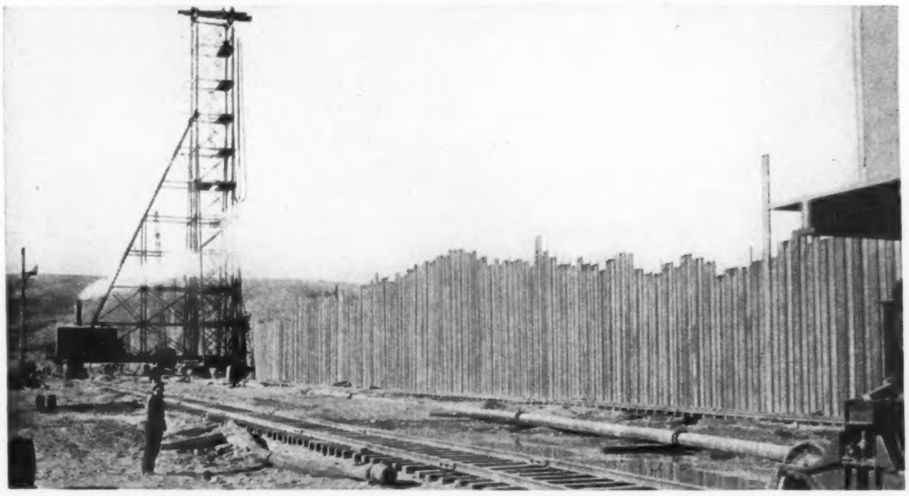
flood plain immediately above and below the dam site offered suitable dam-building material—medium and fine sand intermixed with a small percentage of clay. Moreover, material of this nature could be very easily transferred from one point to another by the use of water.

It is clear that a considerable amount of power is essential to handle such enormous quantities of water and fill. As reported in the previous article, the Missouri River itself is supplying the electrical energy from the Rainbow plant of the Montana Power Company near Great Falls, Mont. The attractive rate offered by this company, which is ready to deliver 50,000 kw. from its available surplus, warranted the construction of the 288-mile, 154,000-volt power line that is now in service.

The principal consumers of this energy are the dredges and the land and floating booster pumps. The dredges, four in number, are mounted on barges of 8x40x170 feet. Each is equipped with two 28-inch centrifugal pumps operating in series and driven by individual wound-rotor induction motors rated at 2,500 hp. and delivering 6,600-volt, 60-cycle, 3-phase current at 257 rpm. In addition, each dredge has a 700-hp., enclosed, externally force ventilated, waterproof induction motor for operating the dredge cutter, as well as a 150-hp. induction motor for driving the winches which raise and lower the dredge ladder and spuds and swing the dredge. The design of the 700-hp. cutter motors is such as to permit mounting them outside on the dredge ladders and operating them tipped downward with the ladders at an angle of 45°. Eighteen portable cable terminals are provided so that power may be taken at any point from the dredge feeder lines in the borrow-pit areas. From these structures a waterproof cable is





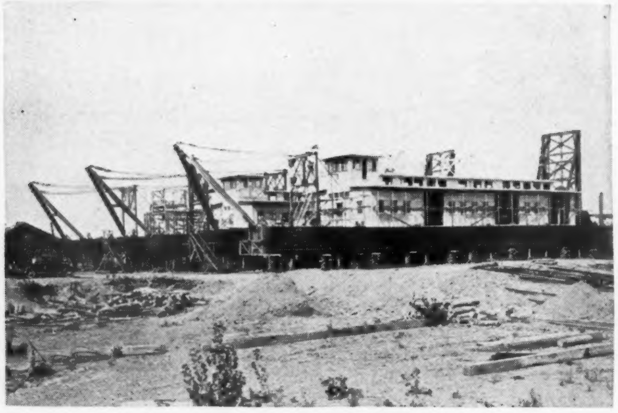


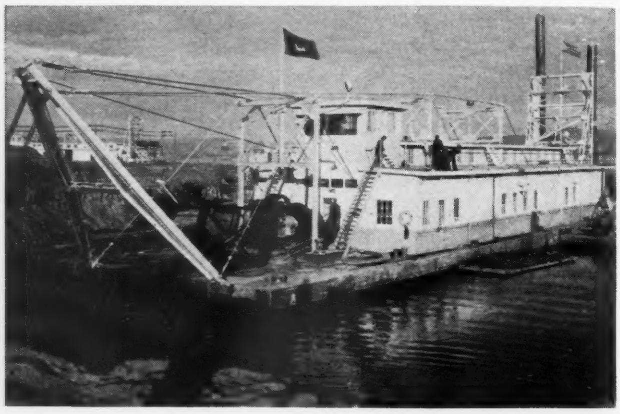
SHEET-PILING CUT-OFF WALL

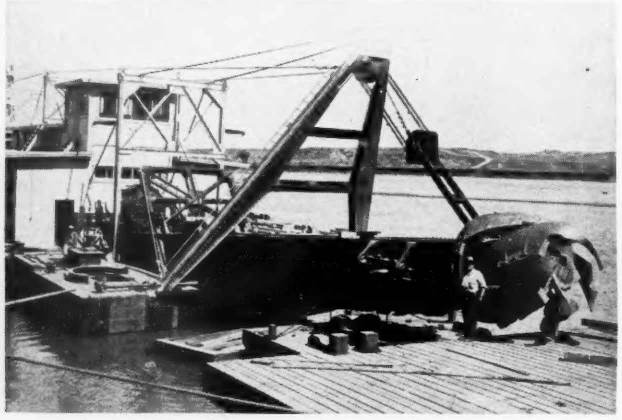
These three illustrations relate to the placing of the sheet-piling wall which will form a barrier against seepage underneath that part of the dam which is in the flood-plain area. This piling is being driven to extreme depths of 155 feet below the ground surface by gantry cranes, one of which is shown in the picture immediately above. Jetting water to assist in the driving of the piling is furnished by four Cameron Class "GT" pumps (center).

READY FOR WORK

In the picture at the right, Dredge "A", barely discernible in the distance, is shown ready to start pumping material through its connecting pontoon-supported line on to the Fort Peck Dam site. The white structure near the center of the picture is the booster pumping plant, which is illustrated in greater detail in the inset. Dredges "B," "C," and "D" are under construction in the boatyard at the upper left.







VIEWS OF FLOATING EQUIPMENT

One of the unique features of the undertaking is the construction and use of floating equipment in a region where navigation is virtually unknown. At the upper left, workmen are framing and calking some of the more than 400 pontoons which are required to support dredge lines. At the upper right, Dredges "B," "C," and "D" are shown under construction on dry land. Dredge "A" (lower left) cutting a channel from the river to the building site to permit floating her sister dredges in a winter harbor. A cutter head, which is the "business end" of a suction dredge, is illustrated at the lower right just after its installation on the ladder of Dredge "A." The 700-hp. driving motor for this cutter may be seen at the far end of the ladder.

carried on pontoons to the dredges and booster barges.

Dredging involves lowering the cutter head until it encounters the river bed and slowly swinging the entire barge from one side to the other, pivoting on one of the two spuds or legs which rest on the bottom at the stern of the dredge. Cables from the barge to "deadmen" on land, or anchors in the water, control the side swing, while movement forward is accomplished by alternately lowering and lifting the spuds to take advantage of the creep first on one side and then on the other.

Located immediately below the rotating cutter head is the intake pipe to the pump units. The passage of the hydraulic fill from the dredges to the final points of deposition on the dam is assisted by 40x100-foot floating booster barges, each of which is equipped with two 2,400-hp. pumps (identical with the dredge-pump installation), as well as by land boosters carrying a single pump. The latter units are mounted on standard railroad trucks for mobility. So that the dredge-pump motors and the booster-pump motors on the same pipe line may divide the load properly, each motor is provided with a special liquid slip regulator that automatically holds the load constant at any given setting by changing the rate of speed.

Between a dredge and its connection with the land pipe line, the 28-inch flanged pipe is supported on pontoons 20 feet square. More than 400 of these have been built at the boatyard, aside from a number of smaller power-cable pontoons. In addition to the four complete units—each consisting of a dredge, a floating booster, and a land booster, the yard has turned out within a period of one year four landing barges, two 25-ton derrick barges, four work barges, four anchor barges, and two ferry barges. Six 40-foot steel launches and two 210-hp. diesel towboats are the only major items in the floating plant that were not constructed at the site. The launches were purchased under contract and the towboats were built at the Government yard at Gasconade, Mo.

Power for dredging was available on October 1, 1934, and soon thereafter the first unit, Dredge *A*, was put to work clearing the necessary channel for the succeeding ones, which were launched later when the river level took a seasonable rise. A channel in front of the boatyard was dredged to a depth of 20 feet; and on October 30, Dredge *A* was swung into a position perpendicular to the waterfront. A harbor about 240 feet wide and nearly half a mile long was cut into the flood plain from the bank of the stream for wintering the craft. This provided a safe, protected haven for the dredges and boosters—the use of an ice saw throughout the cold months successfully having relieved the ice pressure that might otherwise have damaged their hulls. Reference to the outline map will show the location of the two borrow-pit areas immediately above and below the dam site. When the final "lifts" are placed on the dam it will be impossible for the two dredges working the upstream borrow pit to return to the present harbor and they will have to be provided with a base on the western upstream shore.

Full-scale dredging operations are now underway, and will be continued until the completion of the dam, probably in 1939. The tunnels through which the Missouri will be diverted around the dam site during the final stages of the building period are expected to be ready sometime in 1937. They are of the pressure type, and after their temporary service will become the key units in controlling the discharge from the reservoir.

(*To be concluded*).

ENGINEERING EDUCATION

MORE and more frequently, prominent educators and leading engineers are suggesting that changes be made in our present system of educating men for the engineering profession. With engineers among the greatest sufferers from unemployment in recent years, these expressions might, at first glance, be considered merely as temporary reverberations from the economic upheaval. But they are more than that. These critics do not find the engineer wanting in a technical sense. On the contrary, they hold that he is too much a technician. They believe that he would be better able to serve himself and humanity if less stress were placed on his technical education. However, they would do this not by diminishing the teaching of purely engineering subjects but, rather, by supplementing the technical training with a thorough groundwork in cultural subjects.

In an address made three years ago before the Western Society of Engineers, Prof. James Weber Linn, of the chair of English at the University of Chicago, likened the present engineering education formula to the resolve of the Duke of Wellington that he would never read a book unless it promised to give him information that he could put to direct use. Professor Linn's contention was that engineering colleges attempt to train every student to be a general in his profession and overlook or ignore the fact that most of them are destined to be privates. He ventured the opinion that the colleges would be doing a more satisfactory job if they taught those things that would enable graduates to do a private's work effectively—that is, to understand and to carry out orders. "How many engineering school graduates," he asked, "could, after studying a report or investigating a particular set of conditions, make a clear, comprehensive summary of the report or a clear, well-organized statement of the conditions to a superintendent or general manager?"

Between 1920 and 1930 the enrollment of engineering students in American schools increased from 50,000 to 75,000 a year. During that period an average of 10,000 engineering graduates was turned out annually. These young men were specialists in a science that has been charged with having outrun the advancement in the economic, social, and political sciences. Yet, by the very nature of their training, they were equipped to extend this maladjustment. The remedy, according to those who have given the problem serious thought, is to produce a more rounded engineering graduate—one whose mind is better attuned to the social and economic aspects of his work and who will know both how to do a job and why it is being done.

To foster this wider conception of engineering education, there has been formed the Engineers' Council for Professional Development. It proposes that an applicant, in order to secure registration as a professional engineer, shall meet the following minimum qualifications: "Graduation from an approved course in engineering of four years or more in an approved school or college; a specific record of an additional four years or more of active practice in engineering work of a character satisfactory to the examining body (the examining body, in its discretion, may give credit for graduate study in counting years of active practice); and the successful passing of a written and oral examination covering technical, economic, and cultural subjects, and designed to establish the applicant's ability to be placed in responsible charge of engineering work and to render him a valuable member of society."

OUR COVER PICTURE

THIS unusual oil-field study by Orville L. Snider gives an artistic touch to a prosaic subject. The odd-shaped structure at the left is a cooling tower that handles circulating water for two Type XVG gas-engine-driven gas compressors installed in the building at the right.

UNDER THE HUDSON

ONCE more a tunnel is being thrust beneath the Hudson River in New York Harbor. Once more a ponderous, awe-inspiring shield is nosing its way through the silt and ooze of the murky river bottom, while in its wake workmen piece together, ring by ring, the metal skeleton of the tube. Once more the invisible hands of compressed air are holding back the enormous weight of mud and water while the work goes on. Subaqueous tunneling, though no longer a novelty, has lost none of its romance, none of its appeal to the imagination, and little of its mystery to the public at large.

In no branch of construction engineering are more satisfying results achieved. Although they toil literally in the dark, the underwater borers steer their course as surely and as accurately as the mariner at sea. Because of the great danger inherent to such jobs, every conceivable precaution is taken to safeguard the lives of the workers; and statistics will show that casualties are less frequent than in many other fields of endeavor where the risks are nowise so great. The progress that has been made in combating the "bends" or compressed-air illness is particularly gratifying. For this, credit is due the medical profession for determining the nature of the ailment and its proper treatment; to the lawmakers for limiting the hours of labor to safe periods; and, most of all, to the contractors for strictly enforcing precautionary regulations even in the face of the occasional reluctance of their employees to observe them.

It is heartening news that such a project is underway. There has been a long hiatus in this class of construction work during the lean economic years. Unemployment became so serious among New York "sand hogs" that one of their unions gave up the ghost. But there is joy again in their ranks, and the banks of the Hudson once more resound with the shouts of these daring, happy-go-lucky toilers in "high air."

This and That

Anent Washington Monument

An item in our November, 1934, issue, dealing with repairs that were being made to Washington Monument, attributes the spalling of the masonry in the lower part of the structure to a topheavy condition. This view, which was advanced by the U. S. Bureau of Standards, is not shared by Jacob J. Creskoff, structural engineer, who made an extensive study of the dynamics of the monument.

Writing in *The Journal of the Franklin Institute*, Mr. Creskoff ascribes the spalling to the mode of vibration of the monument, as well as to the nature and dimensions of the materials of construction. "The rigid blocks in the lower 150 feet fail," he states, "because they cannot withstand the continuous bending reversals of vibration, the steady alternating push and pull of the mortar on the edges of the rigid blocks causing the spalling. On the other hand, the relatively flexible masonry slabs above, by reason of being better able to withstand the bending reversals, fare much better." Mr. Creskoff therefore predicts that the cutting back and repointing of the joints, work recently carried out, will fail of its purpose because those responsible ignored the fact that the spalling is a dynamic phenomenon. He is of the opinion that, sooner or later, and for the same reasons which caused it previously, spalling will recur.

Mr. Creskoff's investigations were undertaken primarily to ascertain whether or not the monument is earthquake proof. The studies were prompted by the knowledge that the structure, because of a subsurface layer of soft and moist clay, has been settling at the rate of one-fortieth of an inch a year. This condition gives rise to the expectancy that the site, should an earthquake occur, would yield to the vibrations of the monument.

The conclusion reached was that, with the exception of the vicinity of the 417-foot level, the unit stresses of the 44,000-ton, 500-foot-high shaft are all within the allowable values for the stone and mortar of which it is built. This has prompted the prediction that "the Washington Monument is safe on its present site; that if the shaft should be damaged during an earthquake failure will occur near the 417-foot level; that settlement may speed up during major earthquakes, but the monument will survive without serious damage."

* * *

Machines That Run in Hydrogen

The advantages to be gained by providing an atmosphere of hydrogen instead of air for the operation of rotating electrical machinery has been realized for the first time in the case of a frequency changer. Hydrogen-cooled synchronous condensers have been employed for several years. The superiority of hydrogen as a cooling medium, as compared with air, permits a saving in the size of machines of equal power rating. The windage loss with hydrogen is approximately 10 per cent of that with air, being nearly proportional to the relative densities of the gases. There is also an advantage from an electrical standpoint, since the use of hydrogen eliminates the tendency towards the formation of corona. The new frequency changer was made by the General Electric Company for the Pennsylvania Power & Light Corporation and for the purpose of converting 60-cycle, 3-phase power into 25-cycle, 3-phase power to be used in one of the plants of the Bethlehem Steel Company.

* * *

Boom in Mining of Quicksilver

To the student alert to mining trends, the steadily growing worldwide activity in quicksilver or mercury mining gives rise to interesting speculations.

In Germany, the Palatinate Mine, closed for a century, is again being worked, and the government has issued a conservation edict. In Russia, the Soviet Union is paying especial attention to the development of the country's large potential sources of quicksilver. Current output is at the rate of about 200,000 pounds annually, but new mines are being opened and new plants erected.

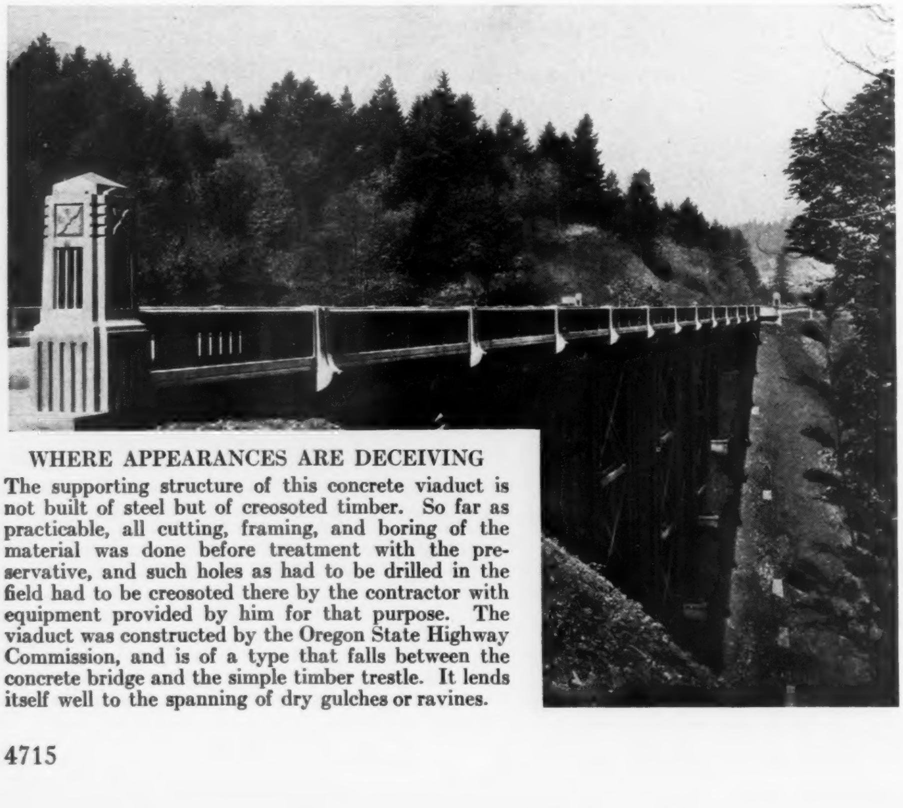
In Italy, Premier Mussolini has recently placed an embargo on mercury exports and, at the same time, has taken steps to increase production. France, although next door to Spain's large quicksilver deposits, has begun to show great interest in four mercury mines in Algeria, where intensive operations are in progress. During the past year one of the mines trebled its output. The present estimated capacity of the four mines is 456,000 pounds annually. The French also own the chief mercury mine of Czechoslovakia, at Mernik, whose output is shipped direct to Paris.

While extensive use is made of mercury for drugs, chemicals, paints, etc., the fact that the manufacturers of ammunition and explosives are largely dependent upon adequate supplies of this metal is regarded in many quarters as the real reason for the boom which has followed closely upon the heels of the failure of the various conferences on international disarmament.

* * *

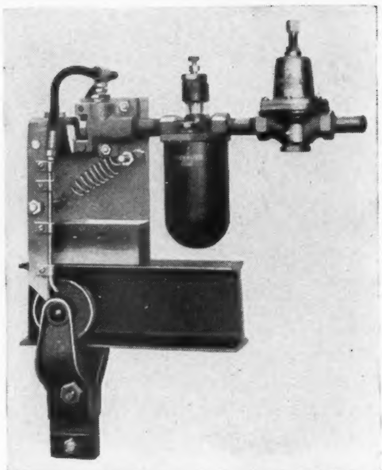
Roads for Cyclists

As more than 100,000 German bicycle riders are involved in accidents each year, the Reich is planning a country-wide web of special paths for that traffic. The first will run from Berlin to Stettin. There are upwards of 15,000,000 cyclists in Germany—20 per cent of all office workers and 60 per cent of the factory workers pedaling to and from their places of employment.



WHERE APPEARANCES ARE DECEIVING

The supporting structure of this concrete viaduct is not built of steel but of creosoted timber. So far as practicable, all cutting, framing, and boring of the material was done before treatment with the preservative, and such holes as had to be drilled in the field had to be creosoted there by the contractor with equipment provided by him for that purpose. The viaduct was constructed by the Oregon State Highway Commission, and is of a type that falls between the concrete bridge and the simple timber trestle. It lends itself well to the spanning of dry gulches or ravines.



AIR-LINE TROLLEY LUBRICATOR

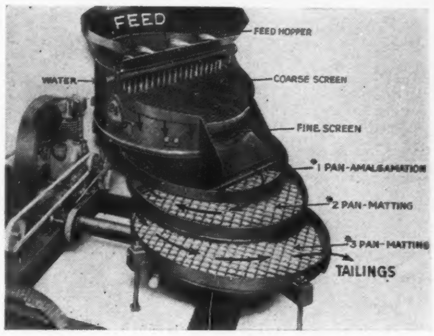
THE satisfactory lubrication of trolley bearings of overhead trolley conveyors presents numerous difficulties. This is especially true where conveyors pass through ovens which tend to cake the lubricant, or through washers which tend to wash it away. Under such circumstances, frequent applications of oil are necessary to prevent wheels from running dry; but, on the other hand, if too much oil is applied there is danger that it will drip upon articles being carried and cause spoilage.

A pneumatic lubricator which is designed to overcome these difficulties is being marketed by the J. N. Fauver Company of Detroit. It was originated by F. Bjerre, a Detroit engineer. It is stationary, and is actuated by triggers which are tripped by the trolley wheel in passing. These triggers open valves which permit a measured amount of oil to be blown upon the bearings at either side of the wheel. Plant air is used, and a standard Norgren reducing valve brings it down to operating pressure. It then goes through a Norgren air-line lubricator, where it picks up the prescribed quantity of oil. The turbulence of the air breaks up the oil, and it is blown into the bearings in the form of fog.

MECHANICAL GOLD PAN SIMULATES ACTION OF HAND PANNER

THE interest in placering—poor man's gold mining—continues unabated the world over. Hand-panning, by reason of its simplicity and low cost, remains the most used method. But even an expert can pan only a small amount of gravel in a day, and exceptionally rich material is required to yield a living wage. In an effort to multiply productiveness without unduly increasing expense, equipment manufacturers have provided scores of different types of small placering machines during the past few years. To have a wide appeal, such a unit must have a low first cost, low operating cost, high efficiency, durability, and portability.

The machine illustrated is termed the Mechanical Gold Pan because it simulates the action of the hand panner. It is self-contained, and equipped with either a gasoline engine or an electric-motor driver. It is 53 inches long, 32 inches wide, and 31 inches high. It can be used for treating placer gravel, mine dumps, and mill tailings, or as an amalgamator for development ore which has been crushed. The standard machine will treat from 1½ to 2 cubic yards of gravel in an hour.



HOW IT WORKS

Hand-panning motion (240 oscillations per minute) is imparted by means of a steel yoke and saddle connected to an inclosed rotating ball-bearing eccentric. The driver which provides this motion also operates a pump to supply water. Gravel shoveled into the feed hopper is washed by a water spray and sized by two successive screens. The coarse material is rejected as tailings, but a lip on the upper screen retains any nuggets. The fines pass successively into three pans, where the gold is caught. The first pan is a mercury-coated copper amalgamating plate, while the second and third pans contain porous rubber matting for catching the finer particles of gold.

NEW PUBLICATIONS

The Austin-Western Road Machinery Company of Aurora, Ill., has issued a special bulletin which describes and illustrates the use of its products in soil-erosion control work. The same concern has produced an attractive pictorial reference catalogue covering its line of machinery for roadbuilders and contractors. Copies may be obtained from the manufacturer.

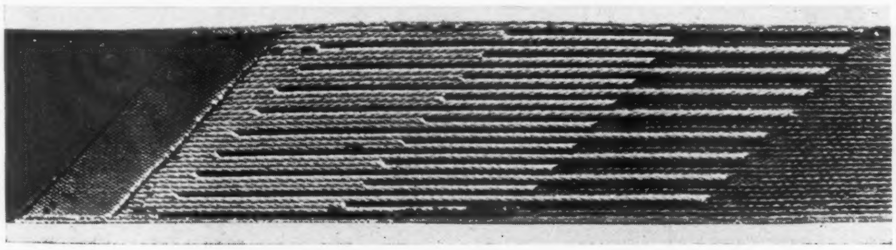
The Coppus Engineering Company of Worcester, Mass., is now manufacturing a new line of air filters for compressors and internal-combustion engines under the name of Coppus Air Filters. Agreements under which the concern formerly made Coppus-Annis filters have been terminated. Two new bulletins which describe the current line of filters are available upon request to the company.

Vim Short-Center Drives with Vim Tred Leather Belting is the title of a new illustrated booklet published by E. F. Houghton & Company, Philadelphia, Pa. It deals with every phase of the problem and, together with a handbook containing specifications covering more than 5,000 short-center drives at every speed and pulley ratio up to 1-6, should be of value to engineers seeking information on the subject. Both are available and can be obtained by addressing the company on your own letterhead.

Under the title of *Two-Stage Air-Cooled Portable Compressors and Tools*, Ingersoll-Rand Company, 11 Broadway, New York, N. Y., has recently published a 56-page bulletin that illustrates and describes this class of portables and the equipment for which it supplies air. The latter includes such of the company's products as "Jackhamers," drifters, wagon drills, sharpeners and oil furnaces, "Jackbits" and grinders, hoists, Cameron pumps, pneumatic tools, etc. Some pages are also devoted to air hose, drill steel and mountings, aftercoolers, "Calyx" core drills, and stationary compressors of different kinds. Users or prospective users especially of portable air compressors will find the bulletin both complete and instructive. In writing for a copy ask for Form 1604-E.

BELTING MADE ENDLESS ON DRIVE BY PORTABLE VULCANIZER

BELT users will be interested to learn that The Goodyear Tire & Rubber Company, Akron, Ohio, has devised a method of splicing and vulcanizing its Compass Cord transmission belting. This means that they can now get such belting in roll lots and make it endless right on the drive without the necessity of dismantling the pulleys, as in the case of an endless belt. The construction of this type of belting is such that the load is carried entirely by cords laid side by side and embedded in rubber and sheathed in a protecting fabric envelope. To splice the ends, the cords are dovetailed and the joint vulcanized with a portable vulcanizer designed especially for the purpose. Goodyear, however, will continue the manufacture of Compass Cord endless belts for drives that permit them to be installed easily and quickly.



Industrial Notes

Smooth-On No. 8 is an aluminum cement for filling in holes, blemishes, and rough surfaces in aluminum castings as well as seams and openings between parts made of that metal. The material is said to harden quickly and to be difficult to detect when properly applied. It is sold in powdered form in quarter-pound cans.

A new type of monel metal which has the strength of alloy steels and the corrosion resistance of regular monel metal has been produced by The International Nickel Company. Its tensile strength reaches more than 160,000 pounds a square inch; it can be readily heat treated; and, in its fully hardened condition, shows Brinell values above 350, although it is available also in softer forms.

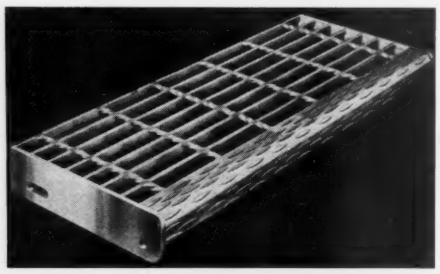
Laminated stainless-steel sheets with a veneer of gold on both sides are a recent development of the General Plate Company, Attleboro, Mass. The material, being cheaper than solid gold, is used in the making of certain jewelry and of parts for dental work. Each layer of gold weighs about one-twentieth as much as the baser metal, to which it is welded so securely that there is little likelihood of their separating during the manufacturing process.

Two years of experimental work has resulted in the development of an insulating cement for furnaces, boilers, ovens, tanks, pipes, etc., that is claimed to withstand heat up to 2,000°F. and to adhere firmly to brick, iron, steel, and other surfaces, whether hot or cold, without cracking or peeling off. It is shipped dry in 80-pound bags and prepared by adding a quart of water to a pound of cement. The material lends itself equally well to patchwork; and from 70 to 80 per cent of it can be reclaimed for re-use.

Powdered chalk, according to one authority, has so far proved itself to be the best material for dusting coal mines to prevent or to check the spread of explosions. When exposed to high temperatures it releases CO_2, thus actually becoming a fire extinguisher. In addition to that, chalk is insoluble in water; adheres well without moisture; intensifies the available light because of its whiteness; has no harmful effect on the workers; and, for a given quantity, will cover twice as much surface as gypsum or lime—crystalline substances widely used in the United States for mine-dusting.

In the Battle Creek, Mich., shops of the Grand Trunk Railway, a small air-operated machine is being found very useful in stamping letters and numerals on identifying tags attached to parts of locomotives dismantled there for overhauling and repair. This work was formerly done by hand; but as anywhere from 125 to 150 tags are ordinarily required for one locomotive, and as there are from three to four characters on each, too much time was spent on their production. Besides doing the stamping, the machine also punches the necessary holes in the tags and cuts them from the strip stock that is fed by hand.

Paints, emulsions, binders, adhesives, and plastics having exceptional chemical resistance can be made from a chlorinated rubber base manufactured by Hercules Powder Company in its new plant at Parlin, N. J. Tornesit, as it is called, is a light yellow or white odorless solid that is claimed to be stable, noninflammable, resistant to acids, alkalies, and other corrosives, soluble in all aromatic hydrocarbons such as benzene, toluene, xylene, etc., and readily miscible with gums and plasticizers. It is considered one of the most important new materials in the protective-coating industry, and promises to be widely used in that and in other fields.



NEW STAIR TREAD

The intersections of the bars in this new Blaw-Knox tread are electroforged into one piece, thereby eliminating rattling and taking full advantage of the strength of the steel of which they are composed. Twisted crossbars provide a roughened surface which affords a grip for shoe soles under all conditions. A nosing of diamond-checkered plate defines the edge of each tread and reduces the chance of a misstep. The grating is easily cleaned and can readily be galvanized or painted to protect it against corrosion.

The Aluminum Company of America has announced the discovery in its research laboratories of an aluminum finish, known as Alzak, which, so it is claimed, prevents the metal from tarnishing and makes it almost as highly reflective as silver. These properties are achieved by an anodic treatment that not only brightens the surface of the metal but also leaves on it a very thin protective oxide film. The latter may be built up by means of another anodic treatment without any material loss in reflective powers. In the case of reflectors and the like, which are exposed to atmospheric conditions, the film is sealed by a special process, making it moisture, stain, and weatherproof.

A newcomer in the paint industry has lately started the large-scale production of a liquid paint that differs radically from those with which we are familiar in that it contains no linseed, fish, or other oils. According to C. L. Welch, executive vice-president of the National Copper Paint Company, the new paint is 98.3 per cent pure copper; is proof against fire, rust, moisture, alkalies, and all other deteriorating elements; and can be applied to any surface. The company's first plant has been opened in Chicago, Ill., and its output consists of three products—namely, the liquid-copper paint, a liquid-copper primer, and a liquid-copper reducer to thin out the paint for spraying.

To cut down its large imports of lubricating oils, Germany proposes to reclaim all such oils used throughout the country. Investigations have shown that from 85 to 90 per cent of them are recoverable, or that approximately 200,000 barrels can be made available for re-use in 1935. While some of these lubricants will not be able to do the work for which they were originally intended, they can be blended with new oils and employed for other purposes. It is interesting to note that the same thing is being done in Russia under government supervision. There large reclaiming plants are in operation and portable units are in use at places that do not warrant shipping the lubricants to the central stations for treatment.

In Koroseal, chemists and engineers of The B. F. Goodrich Company have discovered a substitute for rubber that, in some respects, is claimed to be superior to it. The material is of a different chemical composition, but, like rubber, can be variously compounded so as to give it consistencies ranging from very hard to soft or doughy. It is odorless; can be produced in colors and molded into any desired shape; does not swell and soften when exposed to oils or greases, thus making it ideal for piston packing; and is highly resistant to corrosive chemicals. When announcing the new product, J. W. Schade, director of research of the company, said: "Koroseal will not replace rubber for general use, but laboratory tests and actual field service indicate that it will find increasing usefulness where rubbery consistency, combined with superior resistance to many oils and chemicals or to flexing, is required."